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(12) **United States Patent**
Souda

(10) **Patent No.: US 9,195,209 B2**
(45) **Date of Patent: Nov. 24, 2015**

(54) **IMAGE FORMING APPARATUS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Nov. 14, 2014**

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(30) **Foreign Application Priority Data**

Nov. 15, 2013 (JP) 2013-237324

(51) **Int. Cl.**
G03G 15/00 (2006.01)
G03G 21/16 (2006.01)
G03G 15/01 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/1671*** (2013.01); ***G03G 21/1619*** (2013.01); *G03G 15/0194* (2013.01); *G03G 2221/1684* (2013.01)

(58) **Field of Classification Search**
CPC G03G 21/1619; G03G 21/1671; G03G 2221/1678; G03G 21/16; G03G 2221/1654; G03G 2215/0141
USPC 399/107, 411
See application file for complete search history.

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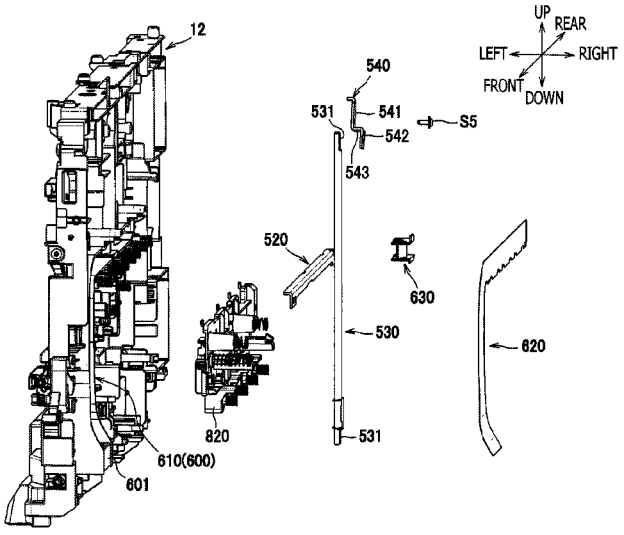
Primary Examiner — Francis Gray
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

An image forming apparatus, including: a plurality of image forming units arranged to align along a direction orthogonal to rotation axes of photosensitive drums; a first frame made of resin and arranged on one side of the photosensitive drums along the direction of rotation axes to support the plurality of image forming units; a first beam made of metal, formed in an elongated shape longitudinally along a direction to intersect with the aligning direction, and arranged along and fixed to a planar face of the first frame; and a second beam formed in an elongated shape extending along the aligning direction, arranged along the planar face of the first frame to intersect with the first beam, and fixed to the planar face of the first frame, is provided. Rigidity of the first beam is higher than rigidity of the second beam.

13 Claims, 21 Drawing Sheets



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Jul. 2, 2015—(US) Non-Final Office Action—U.S. Appl. No. 14/582,630.

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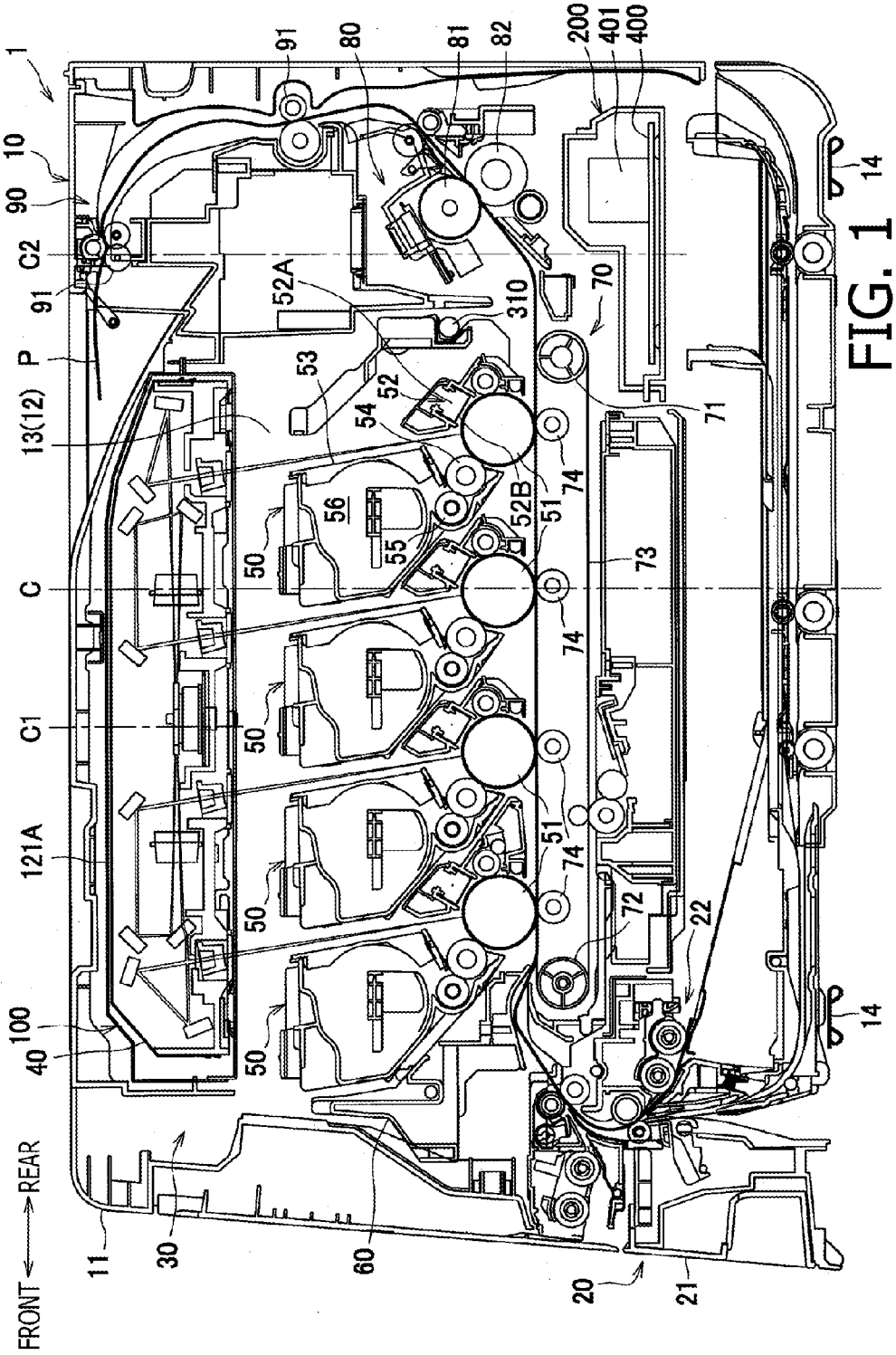
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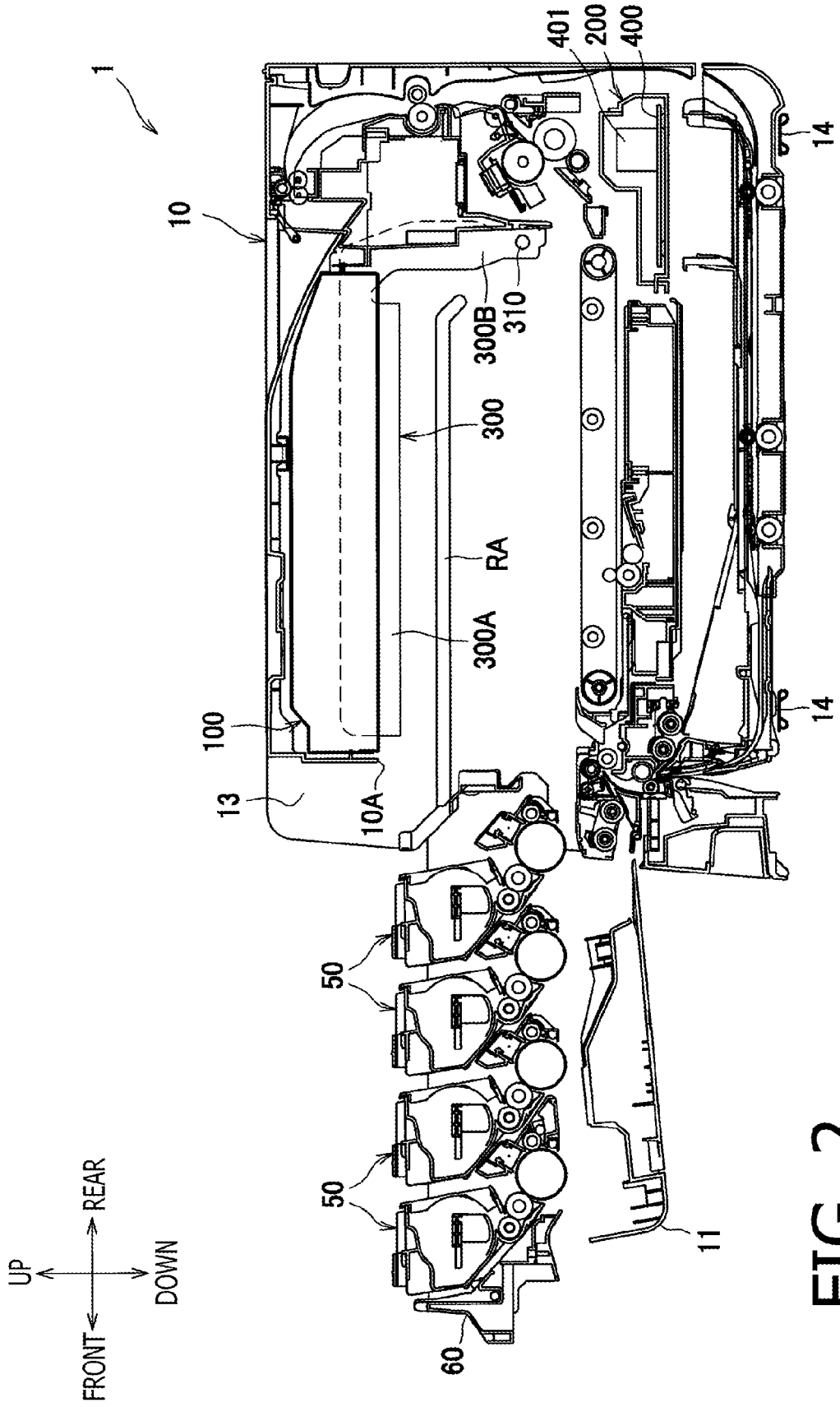
10
90
C2
91
P
13(12)
C
C1
121A
100
40
FRONT
REAR
11
30
60
20
21
91
80
81
82
200
401
400
14
52A
310
70
53
52
54
71
74
56
52B
51
55
50
73
72
22

FIG. 1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10
401
200
400
14
310
300B
300
RA
300A
100
13
10A
50
50
60
11
14
UP
DOWN
REAR
FRONT

FIG. 2

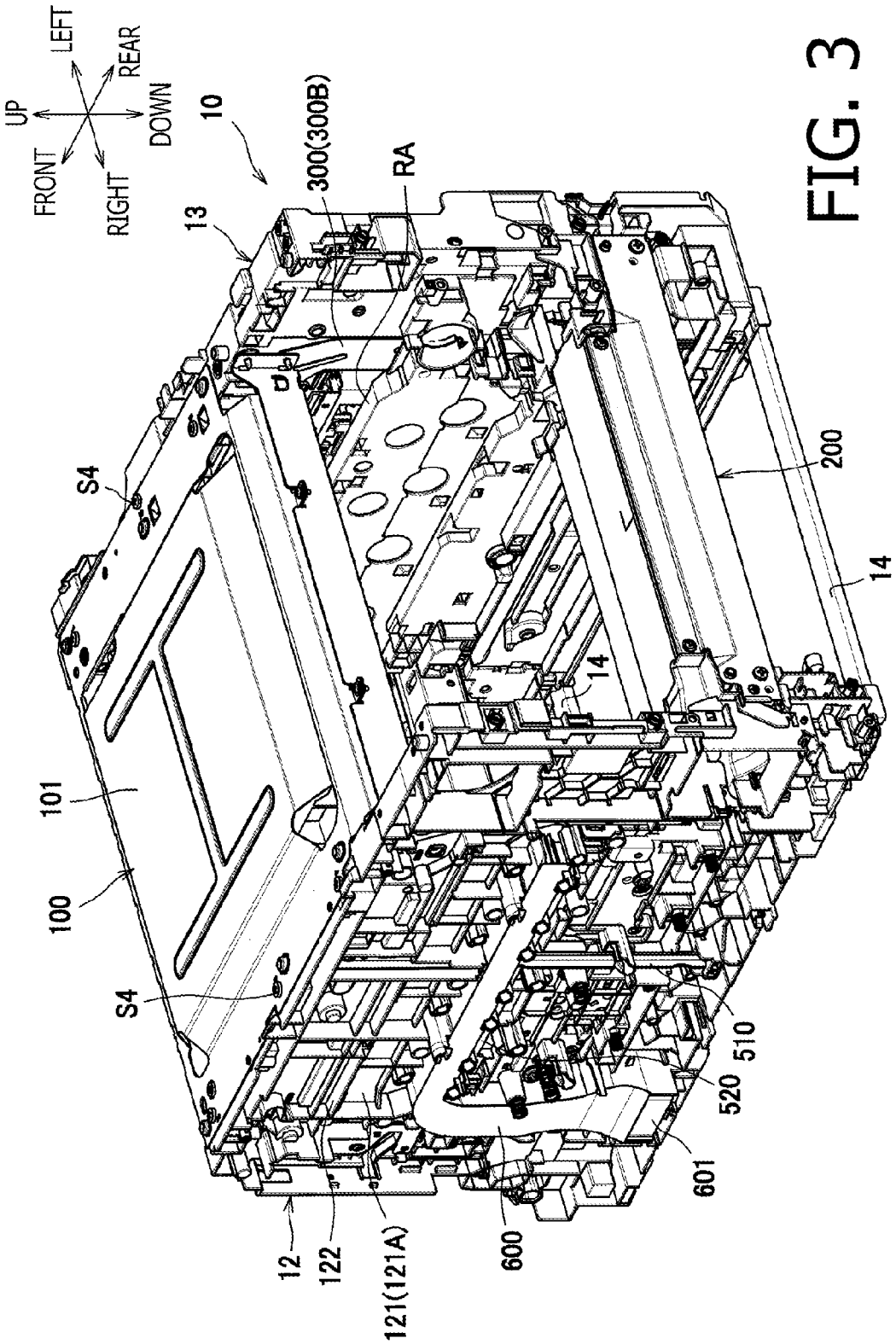

UP
LEFT
REAR
DOWN
FRONT
RIGHT
10
13
300(300B)
RA
S4
200
14
101
100
S4
14
510
520
601
12
122
121(121A)
600

FIG. 3

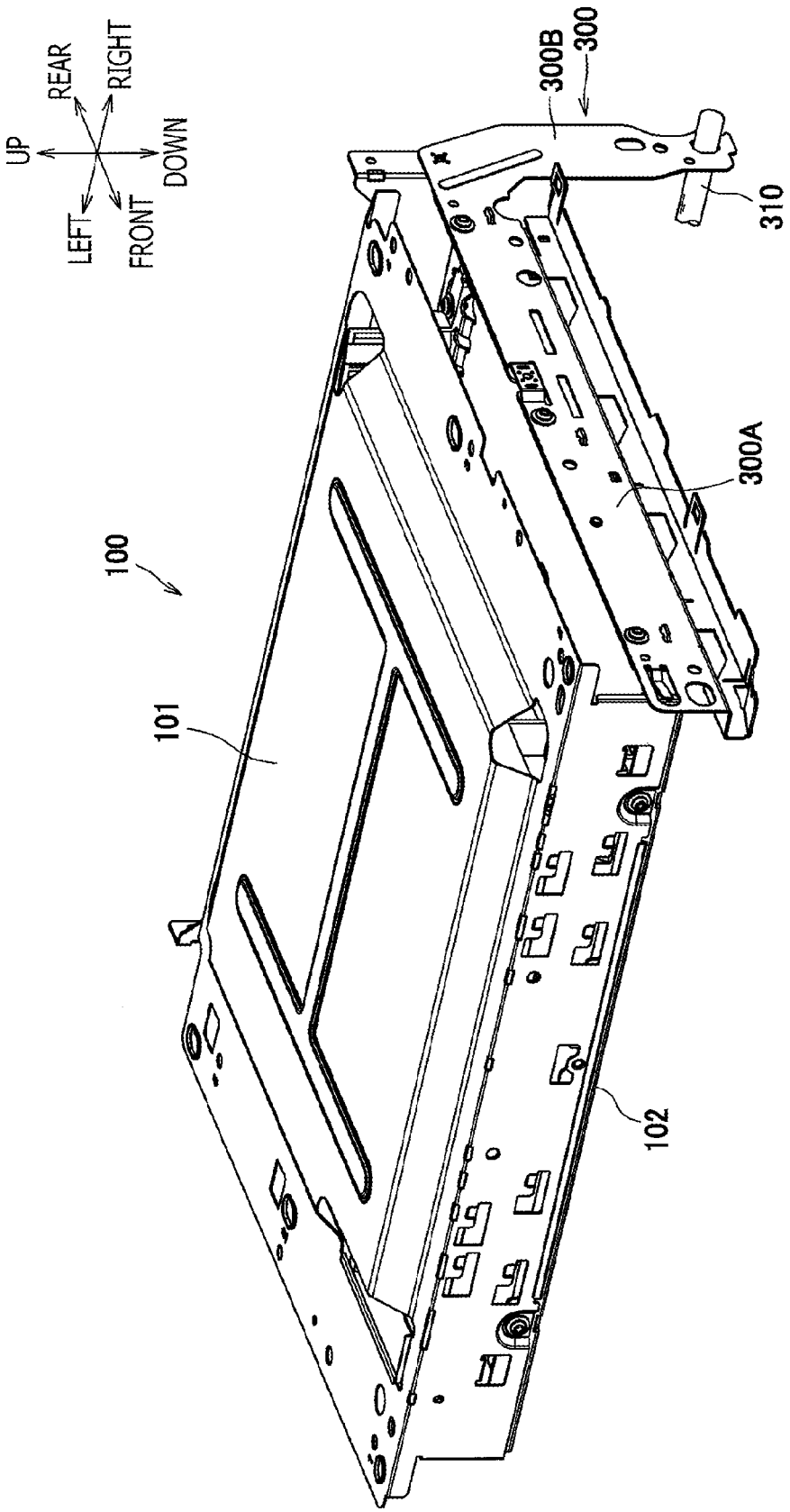


FIG. 4

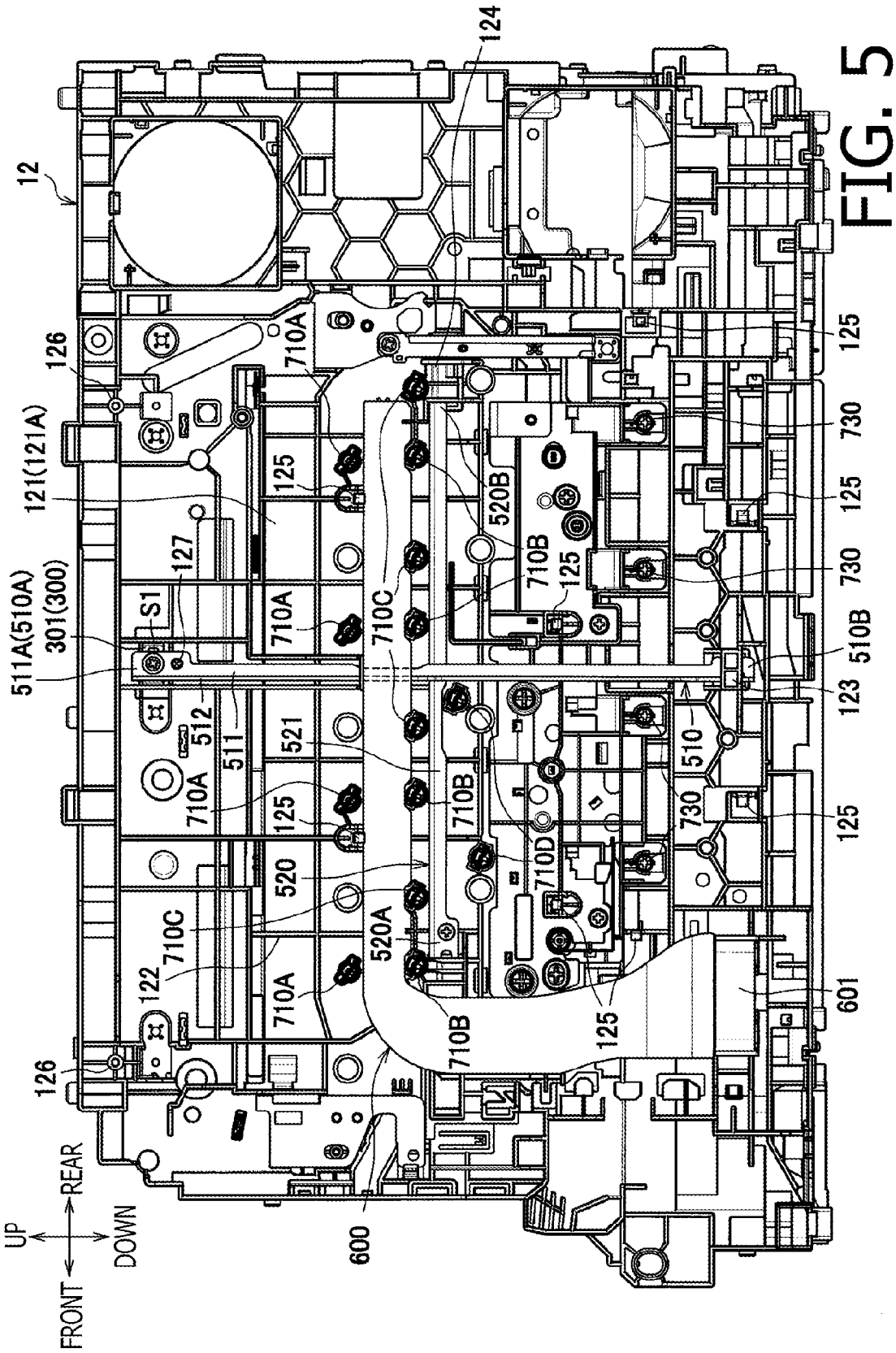

12
124
126
121(121A)
301(300)
511A(510A)
S1
127
710A
710C
710B
710D
125
520B
520
520A
521
511
512
510
510B
730
123
122
600
601
UP
DOWN
REAR
FRONT

FIG. 5

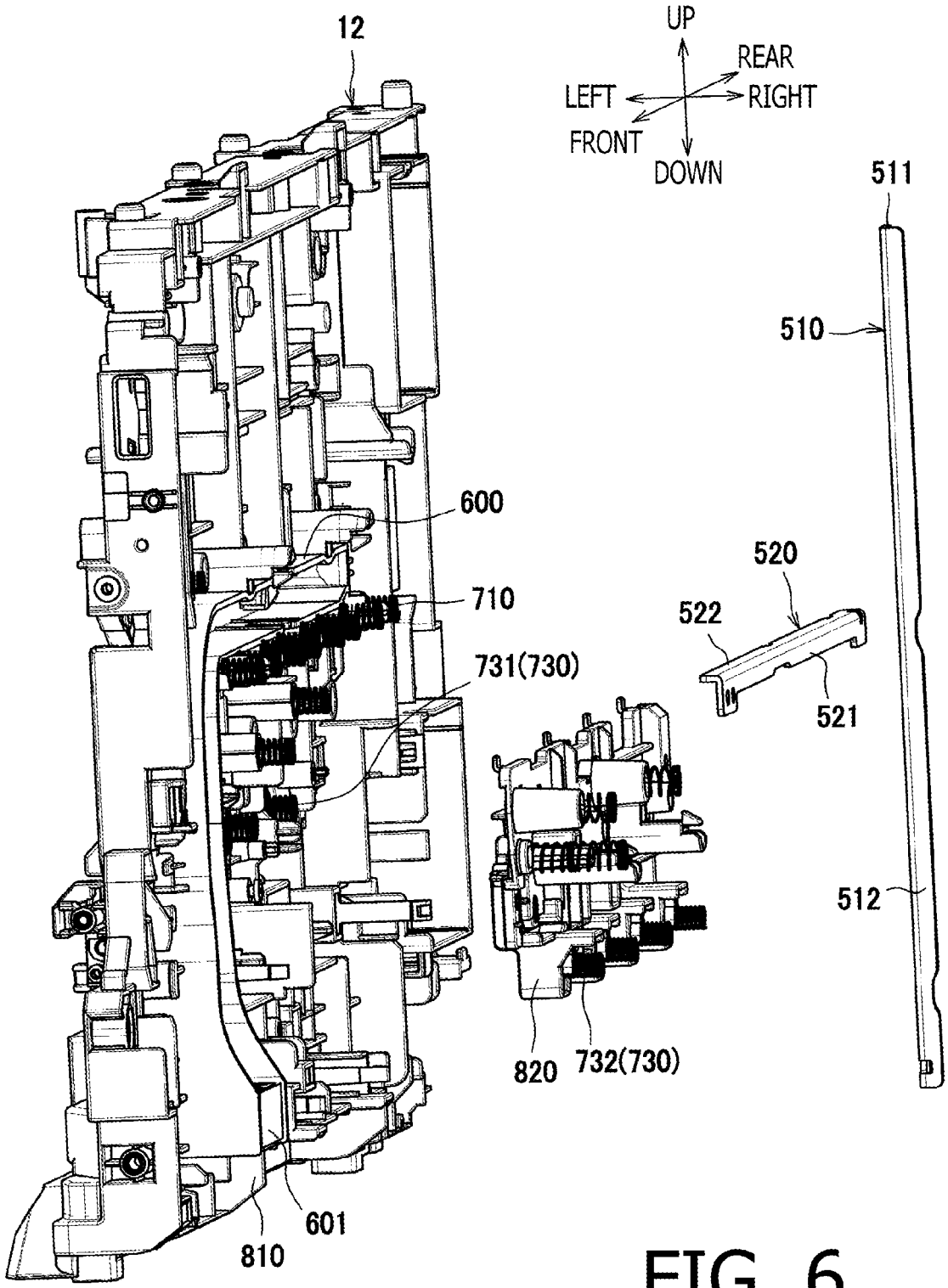

12
UP
REAR
LEFT
RIGHT
FRONT
DOWN
511
510
600
710
731(730)
520
522
521
512
820
732(730)
601
810

FIG. 6

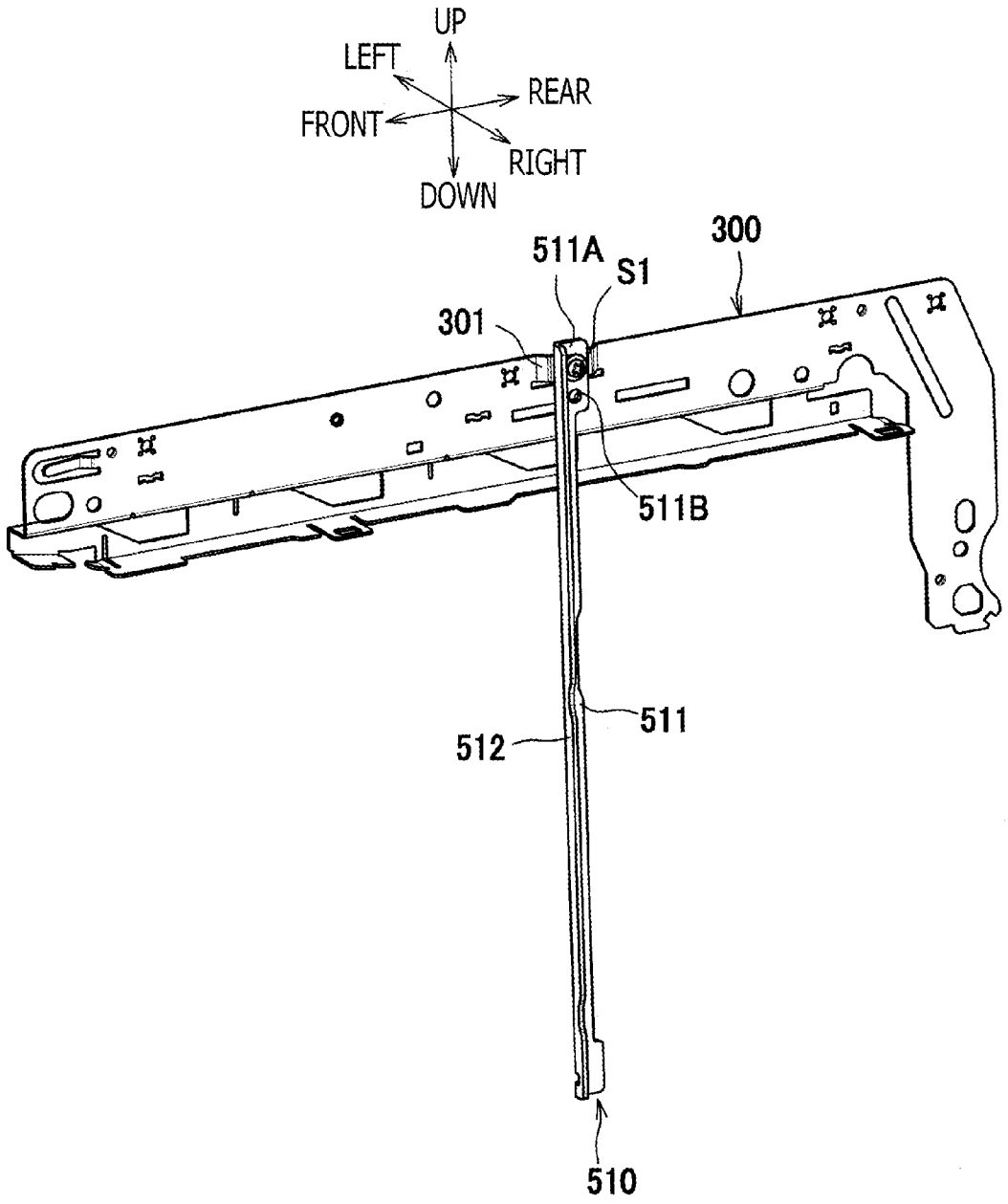
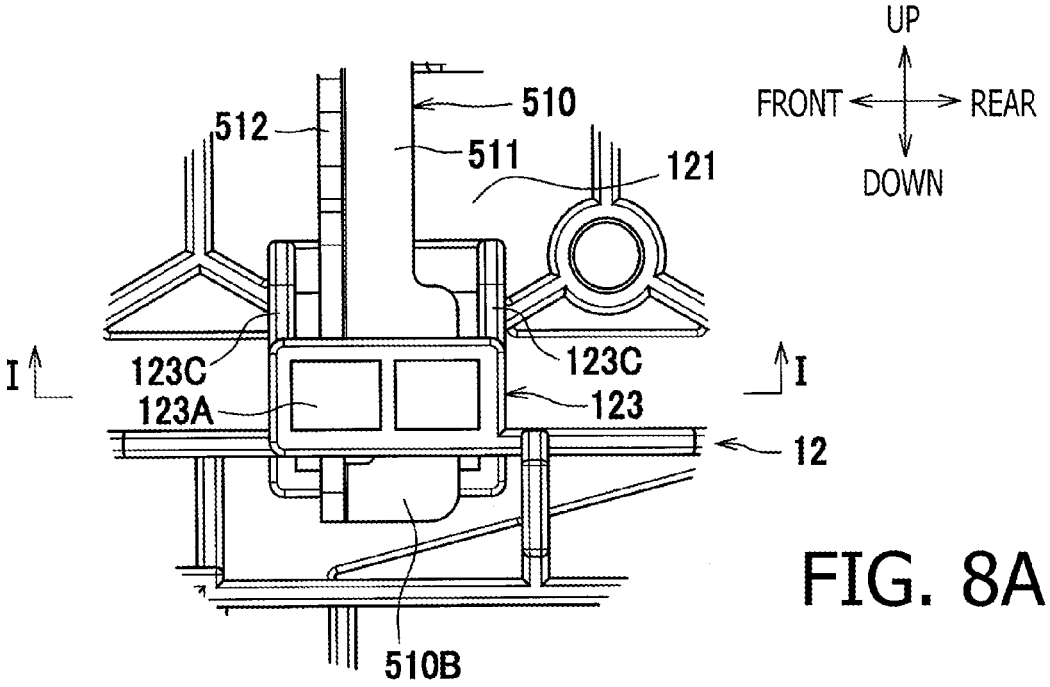


FIG. 7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DOWN
512
510
511
121
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123C
123A
123C
123
I
12
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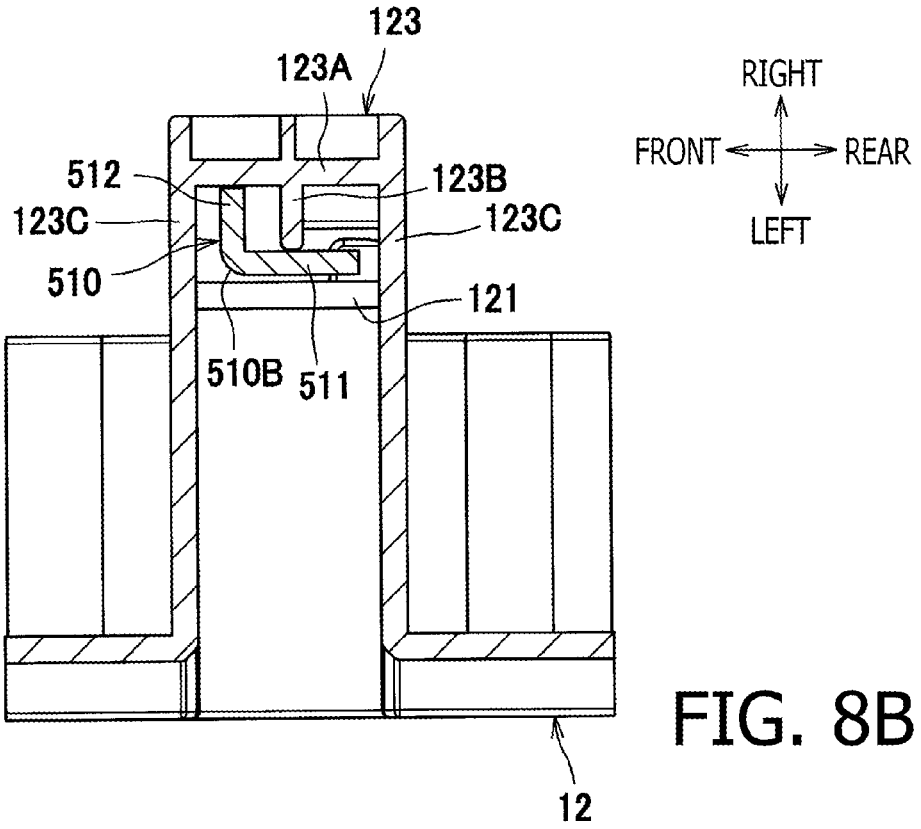
FIG. 8A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123B
123C
123C
510
121
510B
511
12

FIG. 8B

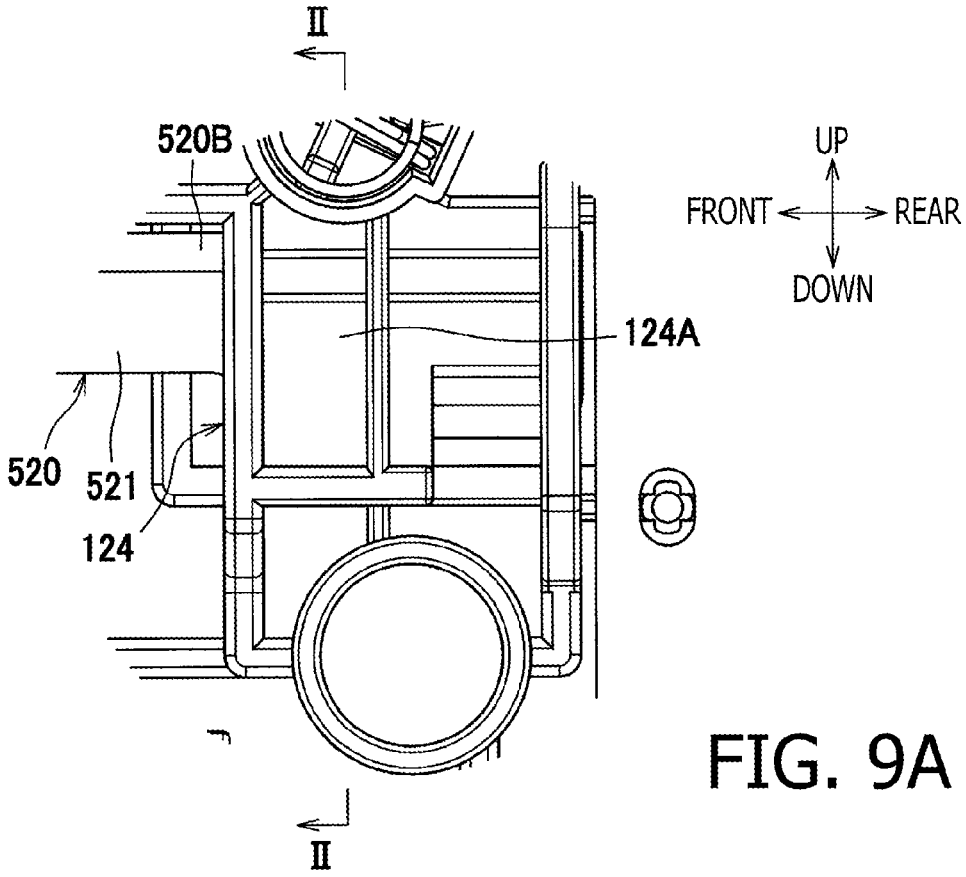

II
520B
UP
FRONT
REAR
DOWN
124A
520
521
124
II

FIG. 9A

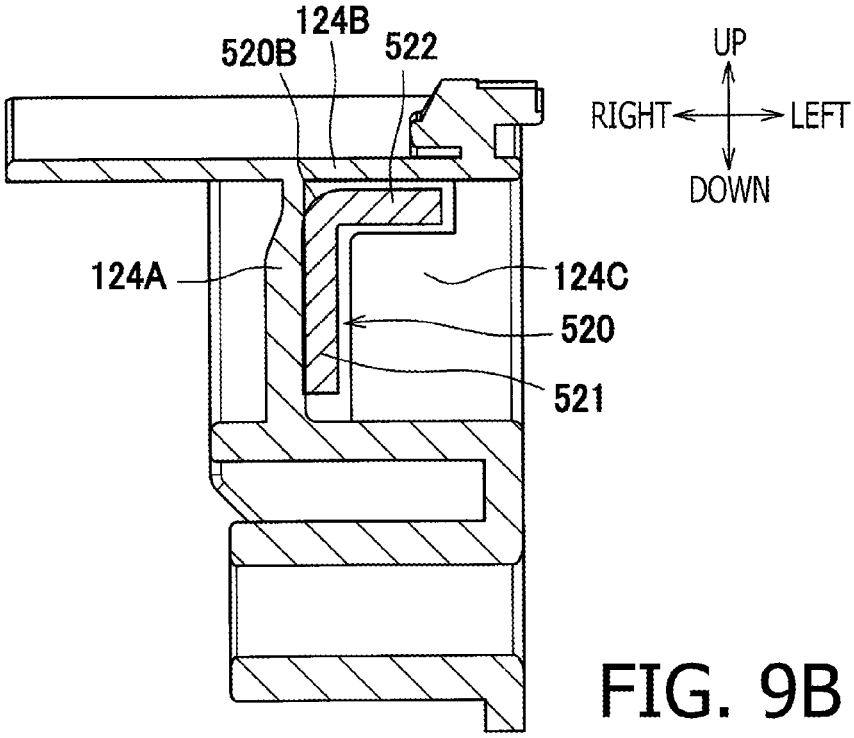

124B
520B
522
UP
RIGHT
LEFT
DOWN
124A
124C
520
521

FIG. 9B

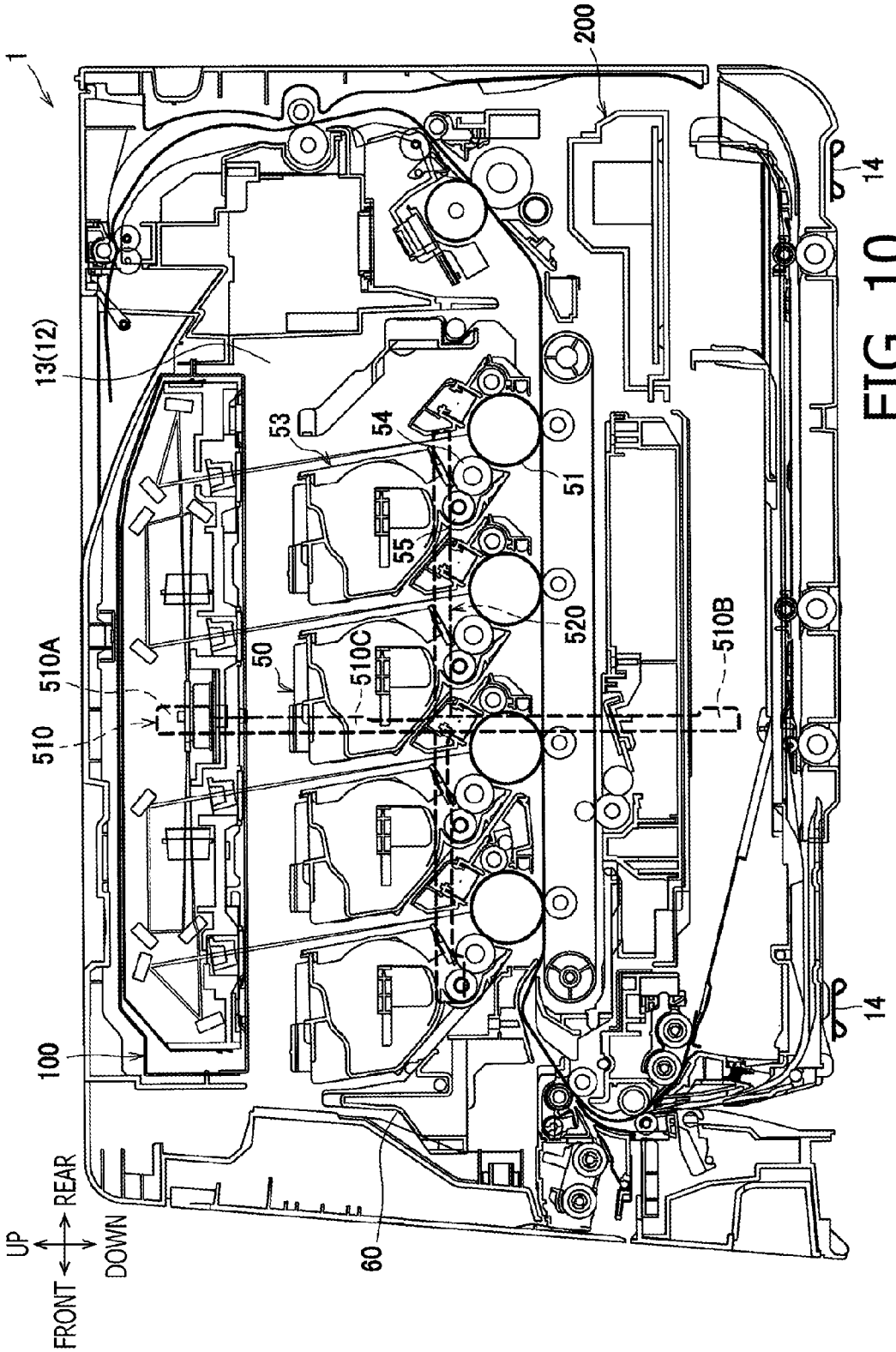

1
200
14
13(12)
53
54
51
55
520
510B
510A
50
510C
510
100
60
UP
DOWN
REAR
FRONT

FIG. 10

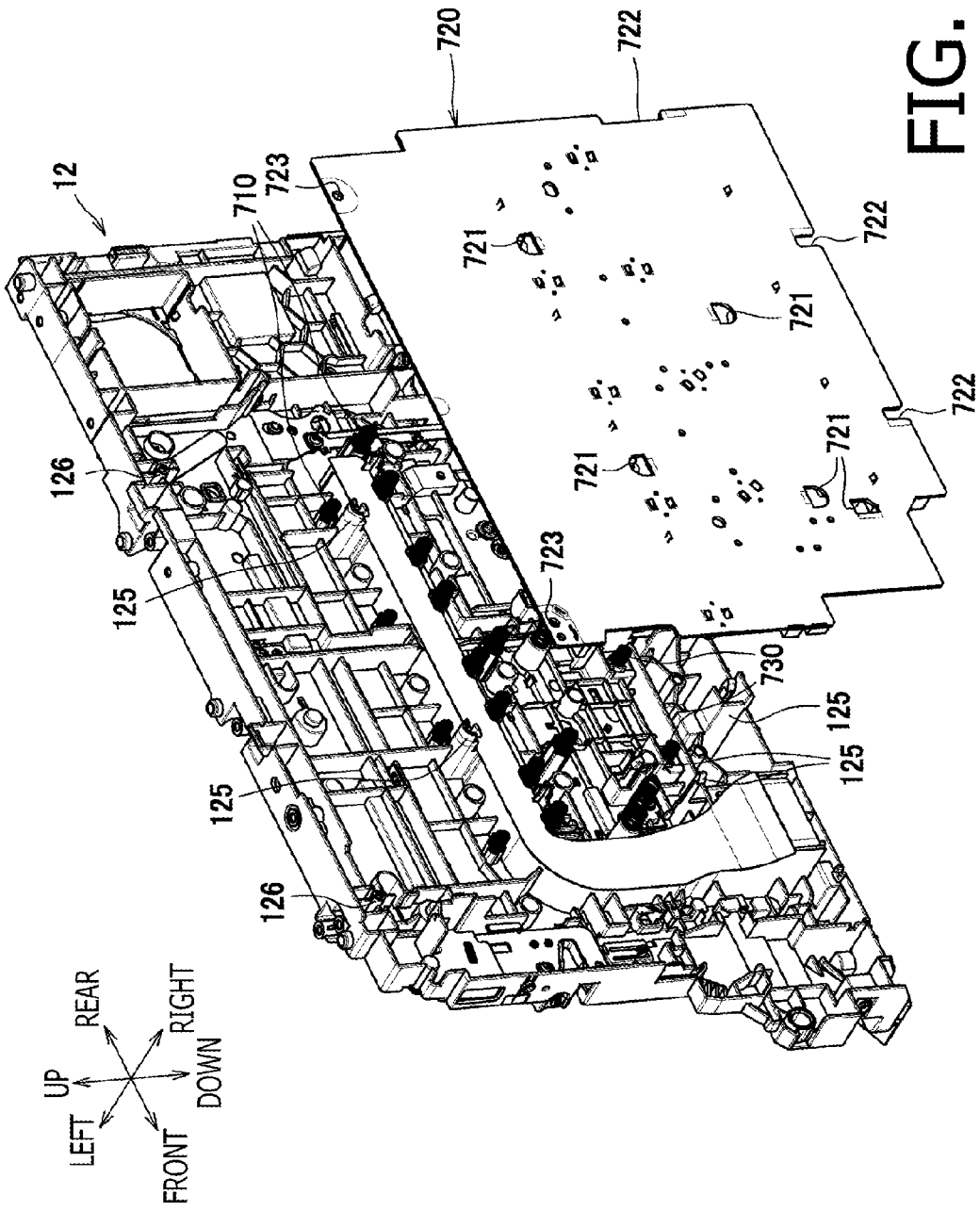

720
722
12
710
723
721
722
721
722
721
721
126
723
125
730
125
125
125
126
UP
REAR
RIGHT
LEFT
DOWN
FRONT

FIG. 11

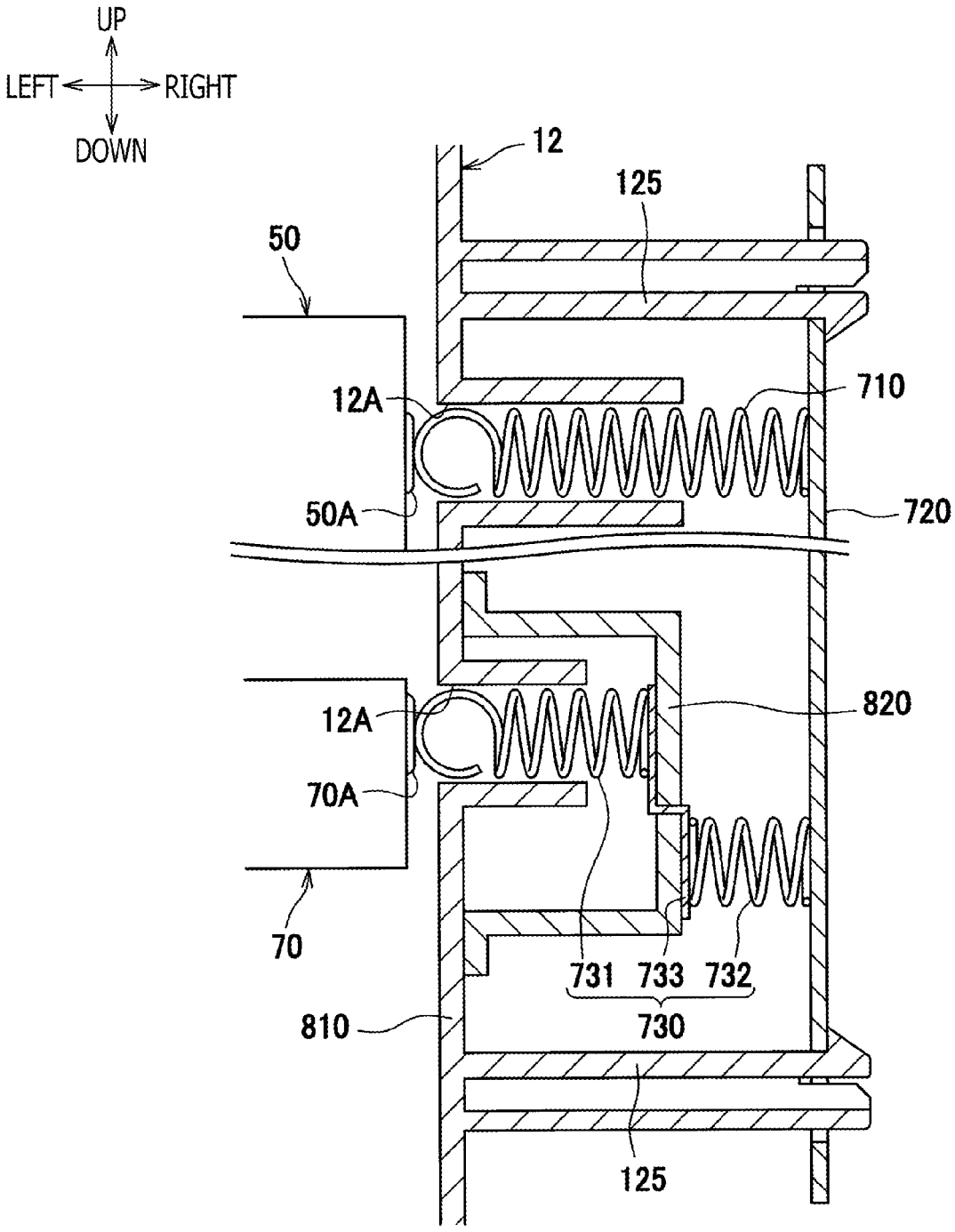

UP
LEFT
RIGHT
DOWN
12
125
50
12A
710
50A
720
12A
820
70A
70
731
733
732
730
810
125

FIG. 12

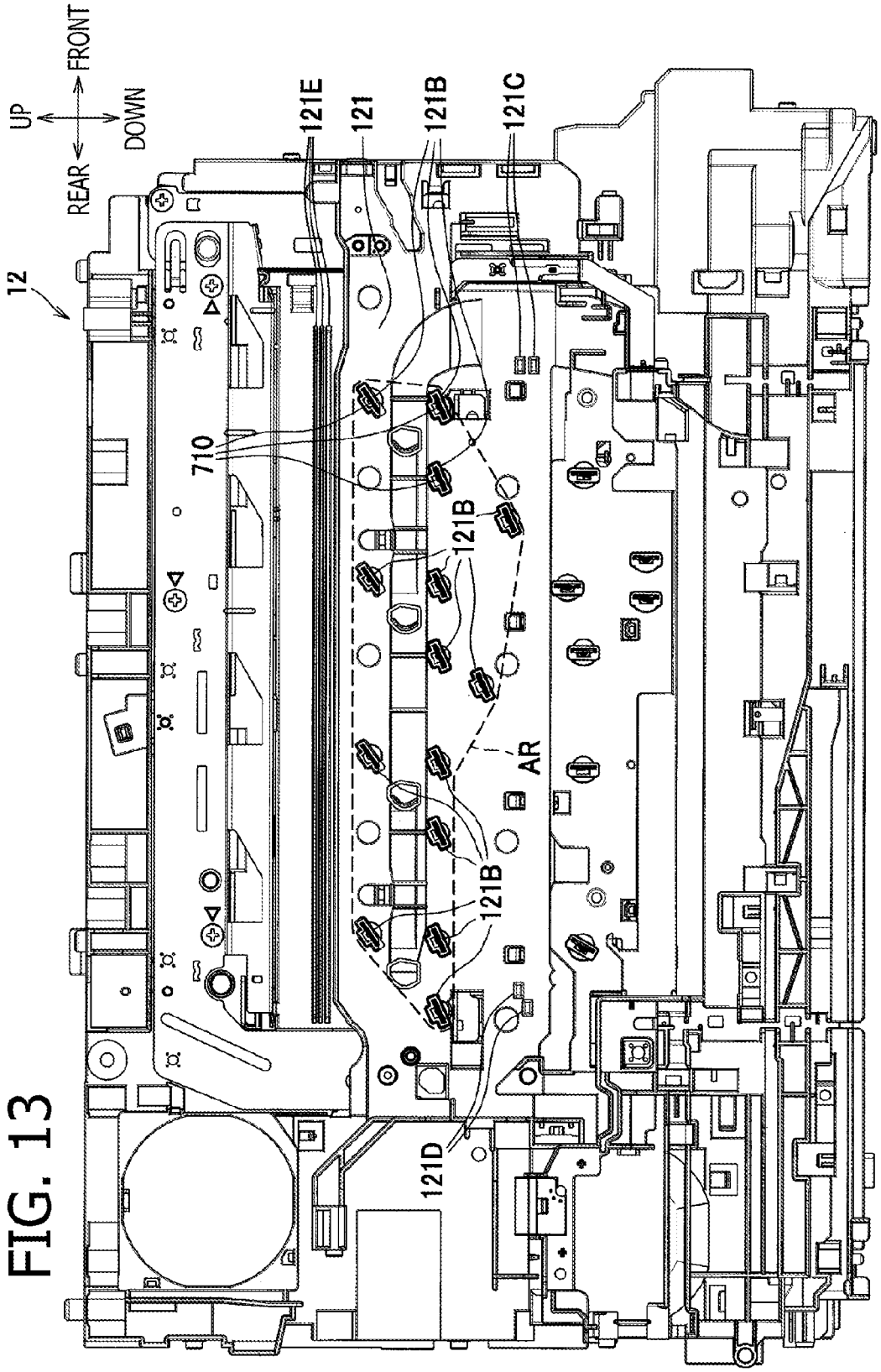


FIG. 13

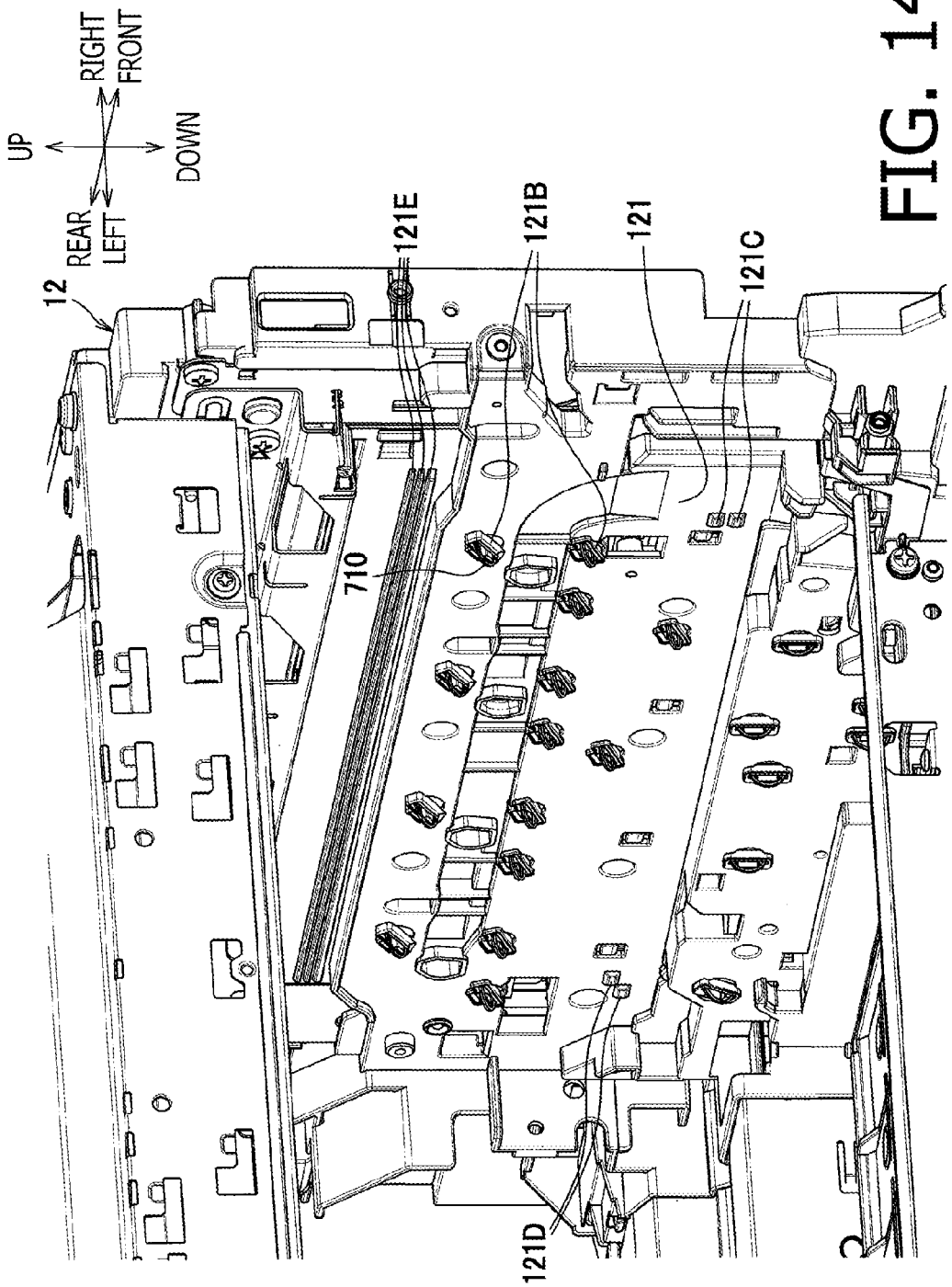


FIG. 14

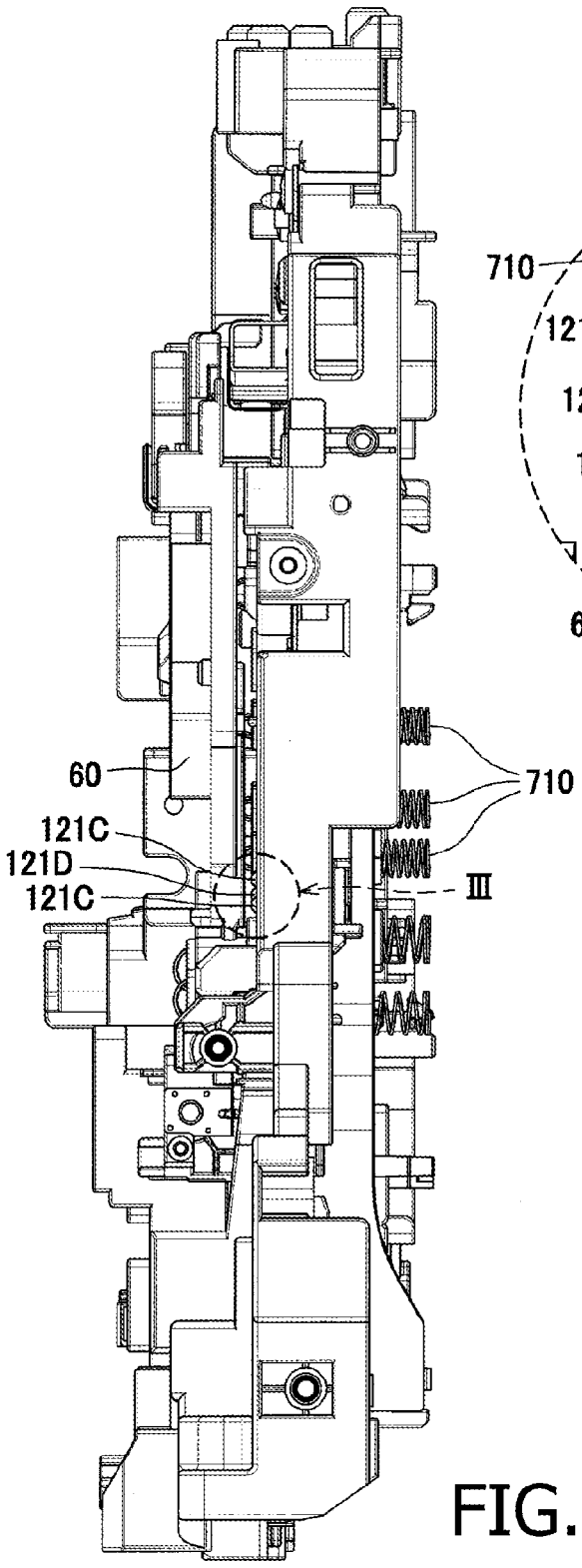


FIG. 15A

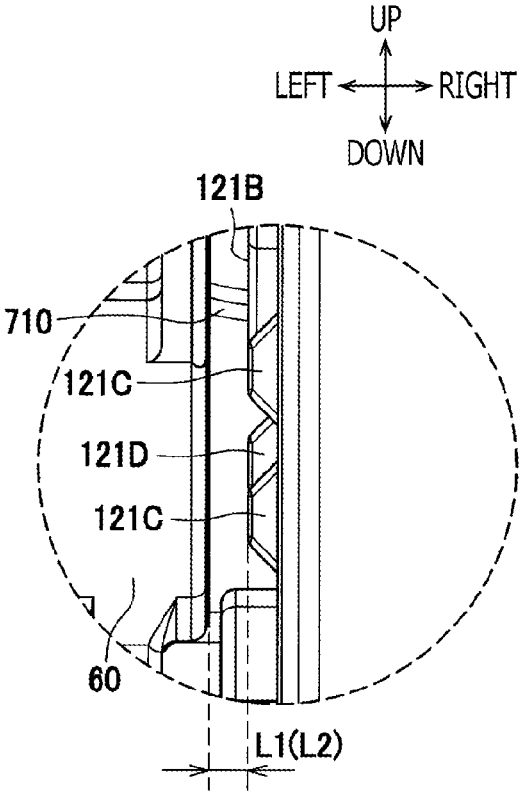
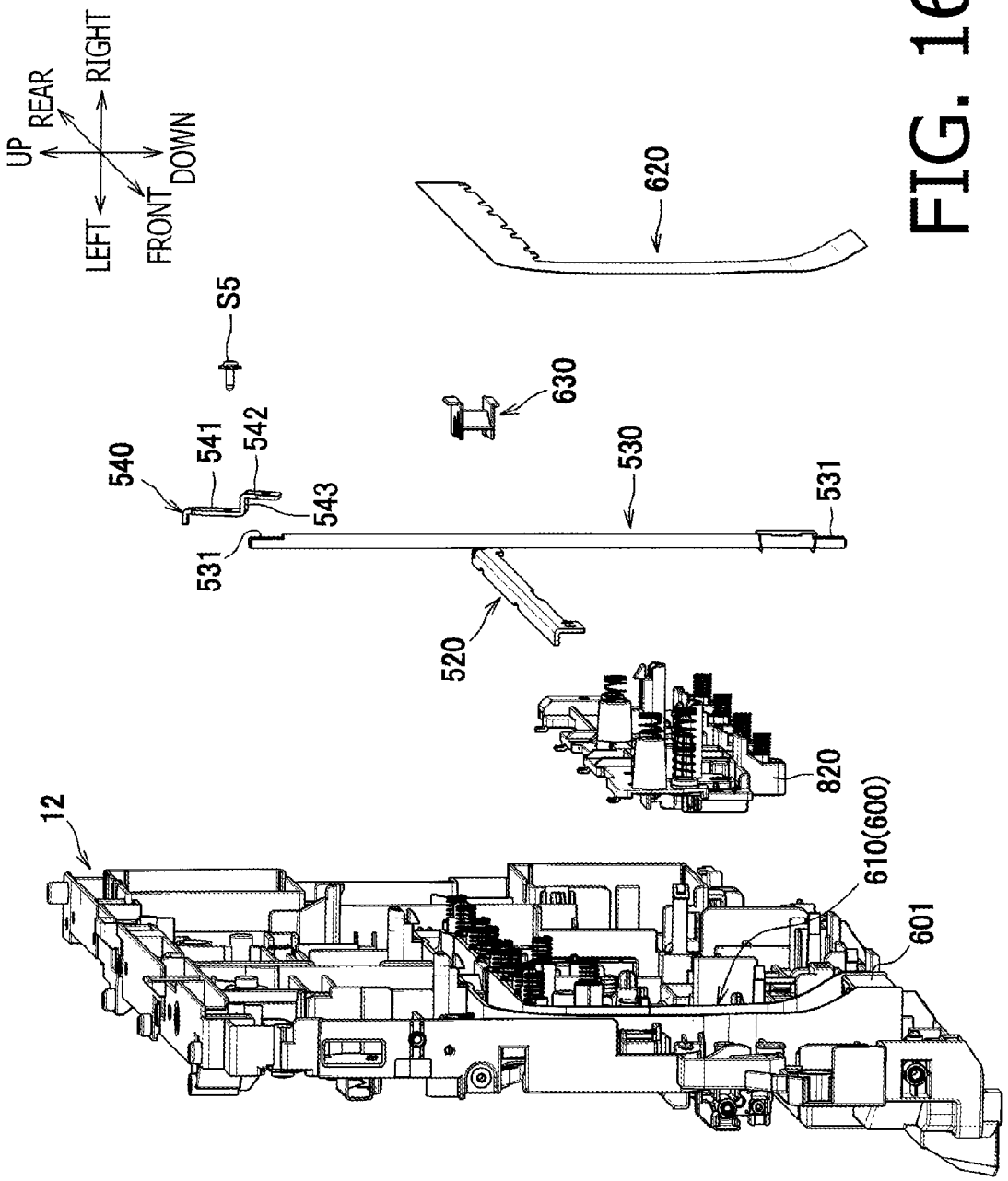


FIG. 15B


UP
REAR
RIGHT
DOWN
LEFT
FRONT
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S5
630
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541
542
543
530
531
531
520
820
12
610(600)
601

FIG. 16

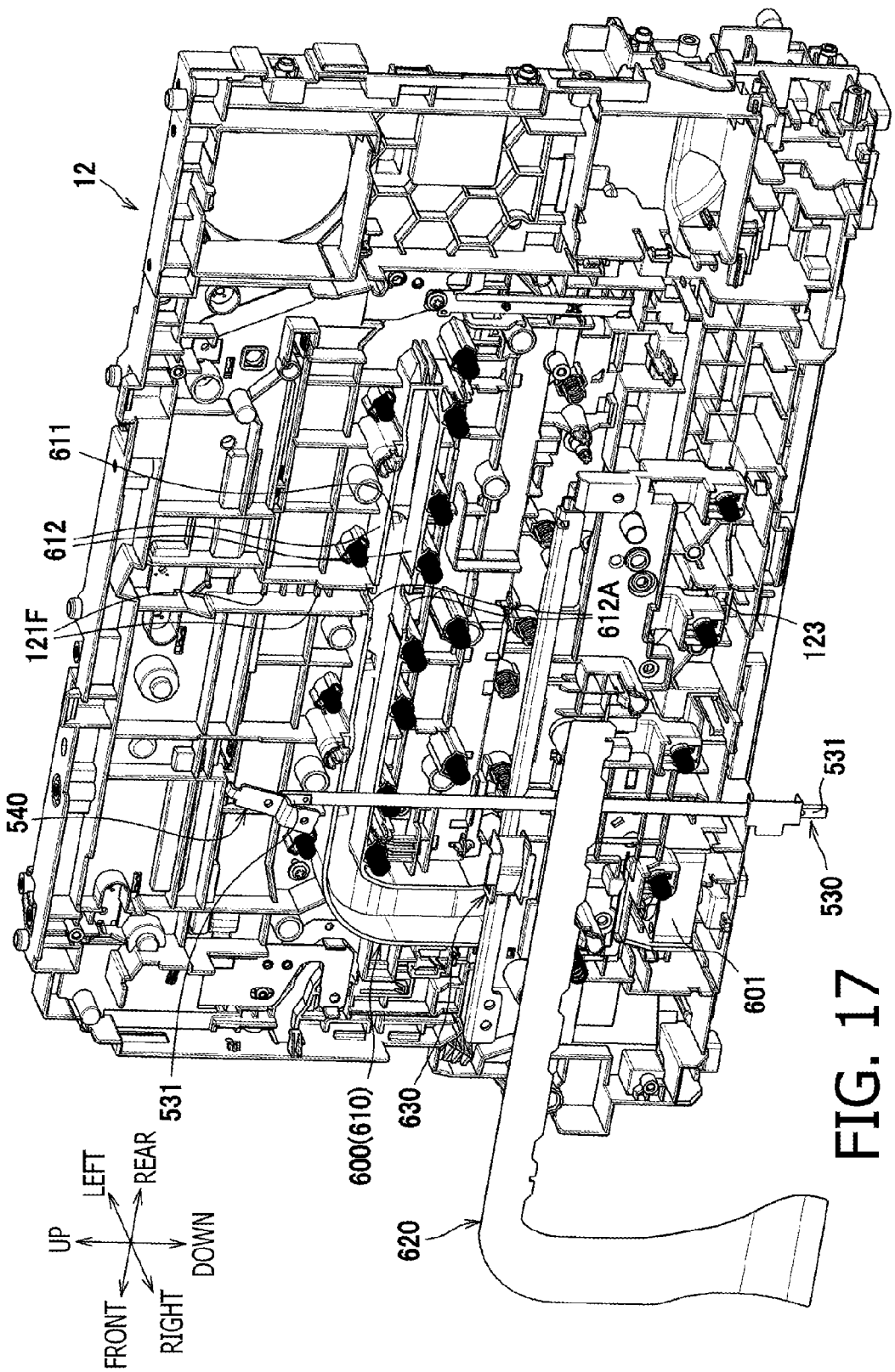
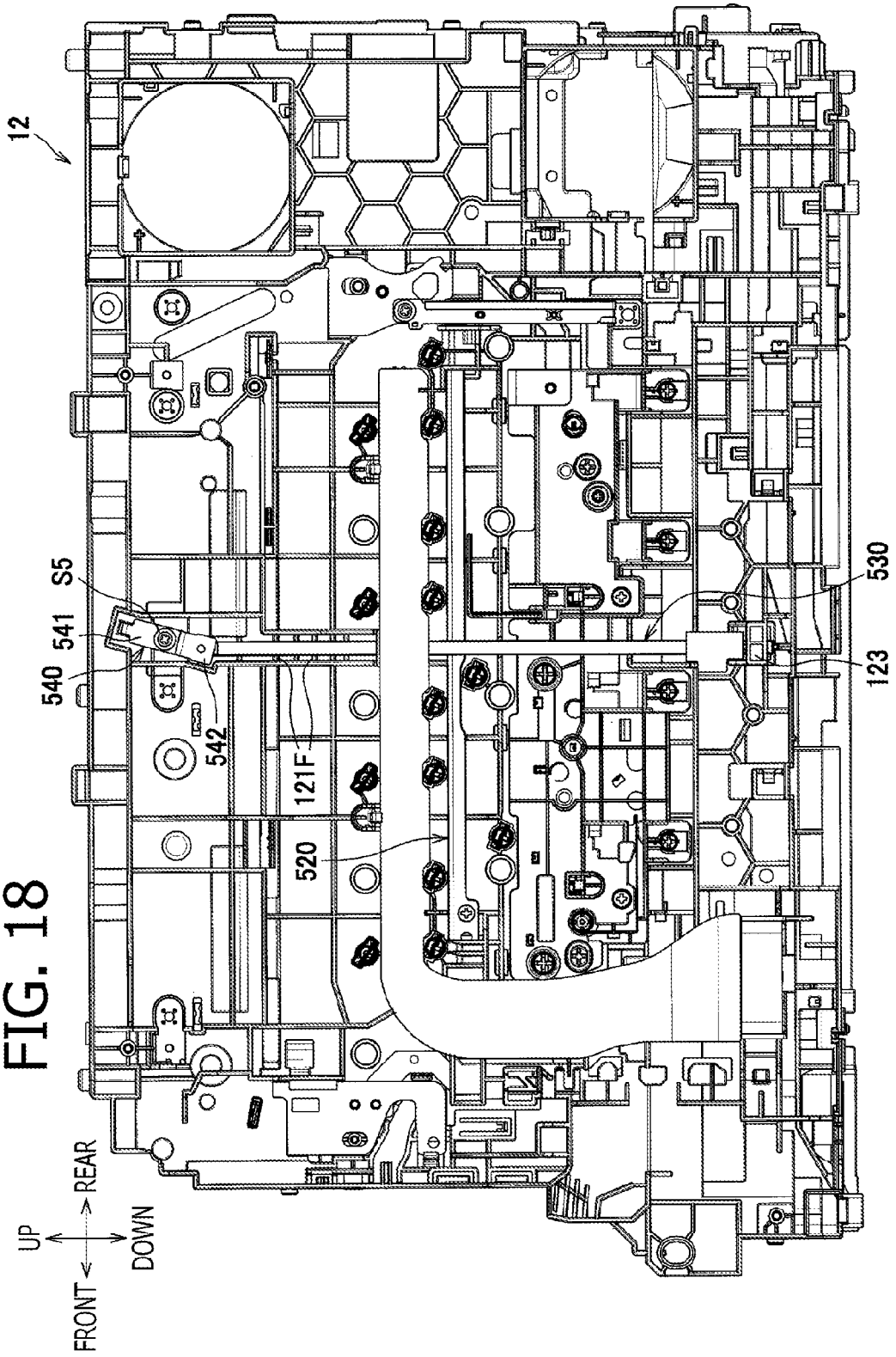

12
611
612
121F
612A
123
540
531
530
601
531
600(610)
630
620
UP
LEFT
REAR
DOWN
FRONT
RIGHT

FIG. 17



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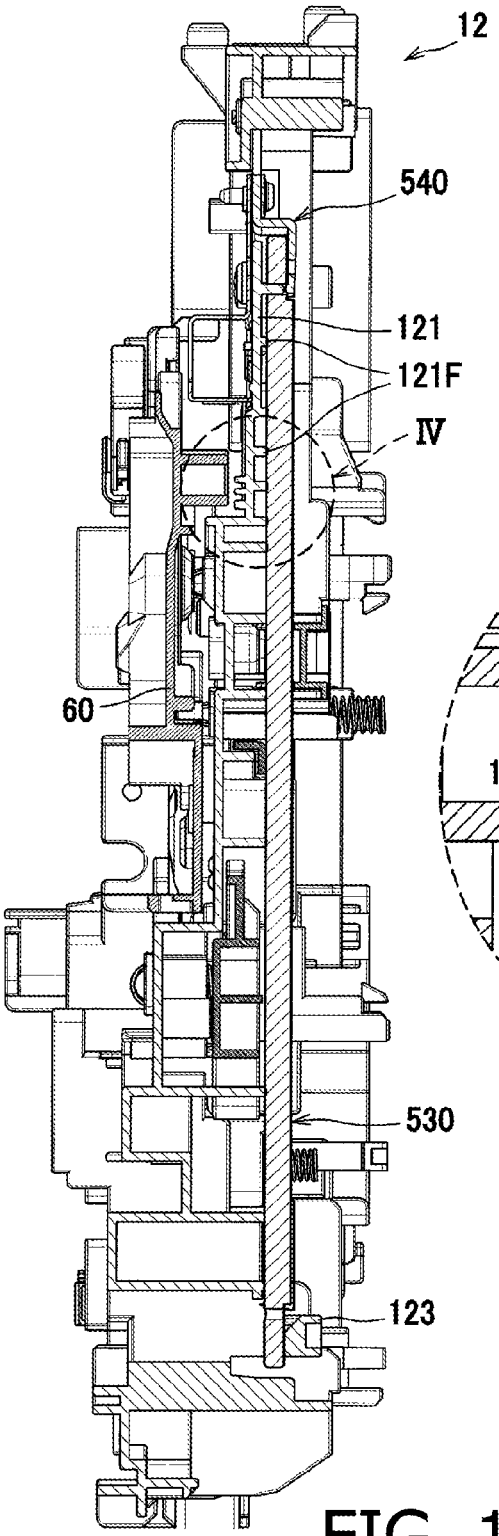
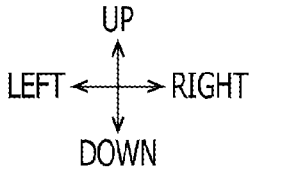
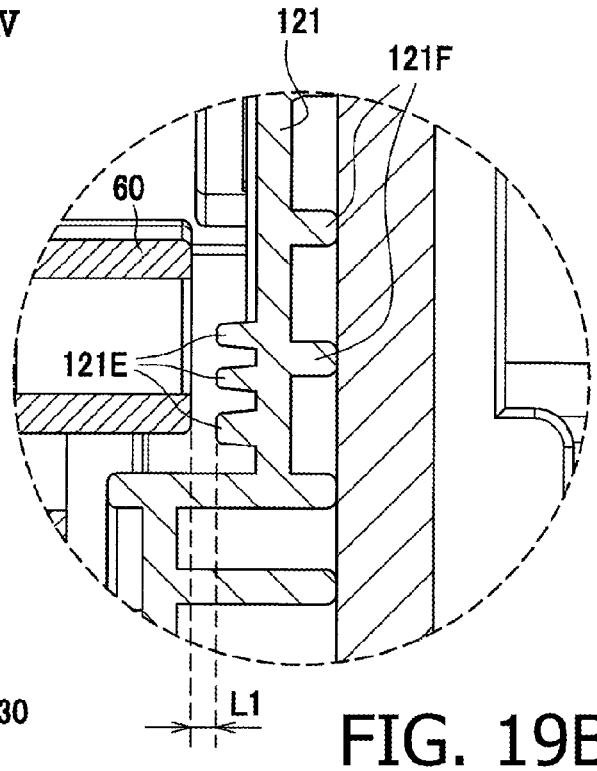


FIG. 19A





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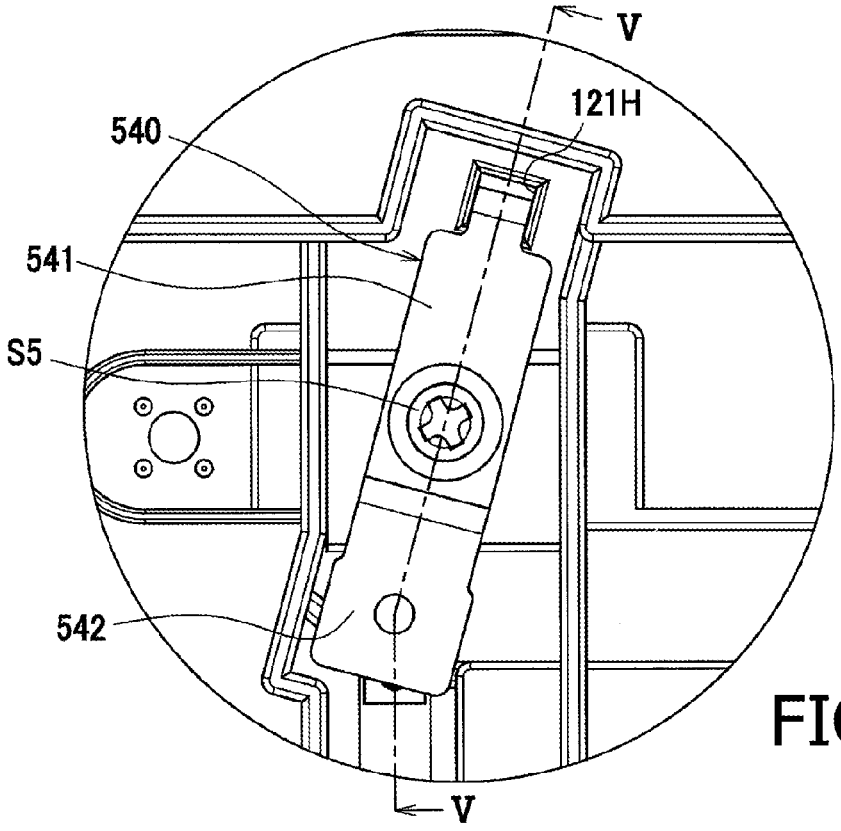

FIG. 20A

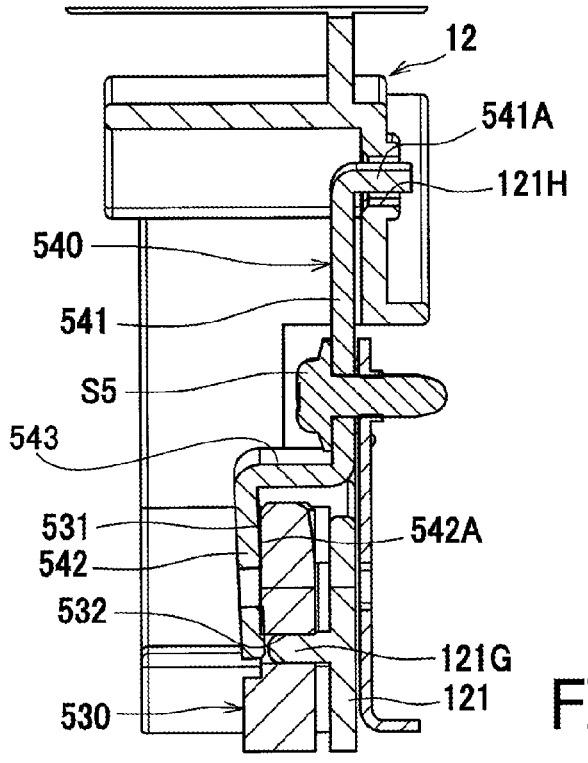

FIG. 20B

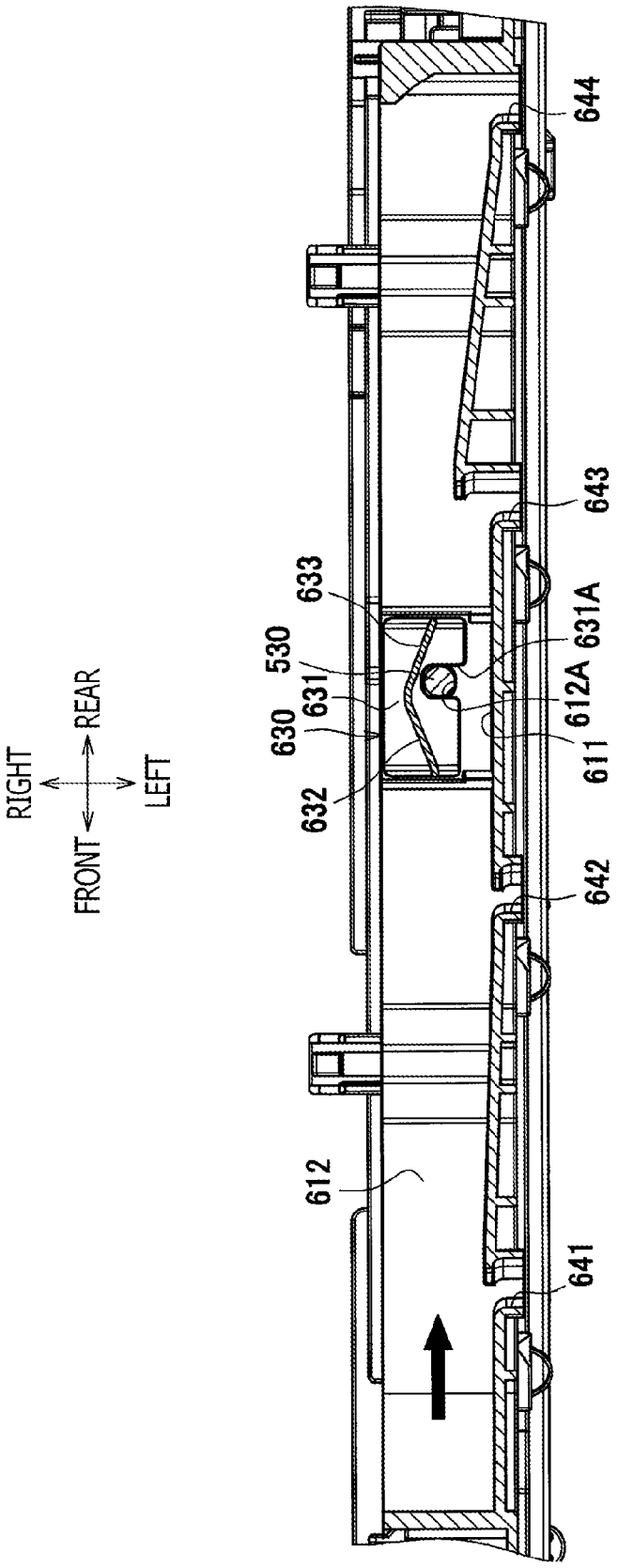
644
643
633
631A
530
631
612A
630
611
632
642
612
641
RIGHT
REAR
LEFT
FRONT

FIG. 21

IMAGE FORMING APPARATUS

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2013-237324 filed on Nov. 15, 2013, the entire subject matter of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

An aspect of the present invention relates to an image forming apparatus having a resin frame, which is configured to support image forming units with a plurality of photosensitive drums.

2. Related Art

An image forming apparatus having side frames, which are made of metal with rigidity, to support an image forming unit laterally, is known. In the image forming apparatus, while the side frames arranged on sides of the image forming unit may be made of metal, resin frames may be coupled to lower ends of the metal frames.

SUMMARY

In the image forming apparatus with the above-mentioned frame structure with the metal-made side frames, a weight of the image forming apparatus may be increased. In this respect, in order to reduce the weight, resin-made side frames may be employed in the image forming apparatus in place of the metal-made side frames. However, the side frames made of resin may be less rigid compared to the metal frames.

The present invention is advantageous in that an image forming apparatus, in which rigidity of a frame to support image forming units is increased while a weight of the image forming apparatus is prevented from being increased, is provided.

According to an aspect of the present invention, an image forming apparatus, including a plurality of image forming units, each of which comprises a photosensitive drum configured to be rotatable about a rotation axis, the plurality of image forming units being arranged to align along an aligning direction orthogonal to a direction of rotation axes of the photosensitive drums; a first frame made of resin and arranged on one side of the plurality of image forming units along the direction of rotation axes, the first frame being configured to support the plurality of image forming units; a first beam made of metal and formed in an elongated shape longitudinally along a direction to intersect with the aligning direction of the plurality of image forming units, the first beam being arranged along a planar face of the first frame and fixed to the planar face of the first frame; and a second beam formed in an elongated shape extending along the aligning direction, the second beam being arranged along the planar face of the first frame to intersect with the first beam and fixed to the planar face of the first frame, is provided. Rigidity of the first beam is higher than rigidity of the second beam.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a cross-sectional side view of a color printer according to an embodiment of the present invention.

FIG. **2** is a cross-sectional side view of the color printer with a drawer being drawn out of a body of the color printer according to the embodiment of the present invention.

FIG. **3** is a perspective view of the body of the color printer with a framework according to the embodiment of the present invention.

FIG. **4** is an exploded view of a first connecting frame and an L-shaped metal piece in the color printer according to the embodiment of the present invention taken from an upper front view point.

FIG. **5** is a lateral view of a right-side frame in the color printer according to the embodiment of the present invention viewed from an outer side along a widthwise direction.

FIG. **6** is an exploded perspective view of the right-side frame, a subsidiary frame, first and second metal beams in the color printer according to the embodiment of the present invention.

FIG. **7** is a perspective view of the L-shaped metal piece and a first metal beam in the color printer according to the embodiment of the present invention.

FIG. **8**A is an enlarged view of a lower part of the first metal beam and a first engageable part in the color printer according to the embodiment of the present invention. FIG. **8**B is a cross-sectional view of the lower part of the first metal beam and the first engageable part in the color printer according to the embodiment of the present invention taken along a line I-I shown in FIG. **8**A.

FIG. **9**A is an enlarged view of a rear part of a second metal beam and a second engageable part in the color printer according to the embodiment of the present invention. FIG. **9**B is a cross-sectional view of the rear part of the second metal beam and the second engageable part in the color printer according to the embodiment of the present invention taken along a line II-II shown in FIG. **9**A.

FIG. **10** is a cross-sectional side view of the color printer with the first and second metal beams and processing units according to the embodiment of the present invention.

FIG. **11** is an exploded perspective view of spring electrodes and a substrate in the color printer according to the embodiment of the present invention.

FIG. **12** is a cross-sectional view of the right-side frame with the spring electrodes and the substrate in the color printer according to the embodiment of the present invention.

FIG. **13** is a lateral view of the right-side frame in the color printer according to the embodiment of the present invention viewed from an inner side along the widthwise direction.

FIG. **14** is a perspective view of the right-side frame in the color printer according to the embodiment of the present invention viewed from the inner side along the widthwise direction.

FIG. **15**A is a front view of the right-side frame in the color printer according to the embodiment of the present invention viewed along a front-rear direction. FIG. **15**B is an enlarged partial view of an area indicated by a sign III in FIG. **15**A according to the embodiment of the present invention.

FIG. **16** is an exploded perspective view of the right-side frame, a subsidiary frame, first and second beams, and accompanying parts in the color printer according to a second embodiment of the present invention.

FIG. **17** is an exploded perspective view of the right-side frame, the first and second beams, and accompanying parts in the color printer according to the second embodiment of the present invention.

FIG. **18** is a lateral view of the right-side frame in the color printer according to the second embodiment of the present invention viewed from the outer side along the widthwise direction.

FIG. **19**A is a front view of the right-side frame in the color printer according to the second embodiment of the present invention viewed along the front-rear direction. FIG. **19**B is an enlarged partial view of an area indicated by a sign IV in FIG. **19**A according to the second embodiment of the present invention.

FIG. **20**A is an enlarged partial view of a plate piece in the color printer according to the second embodiment of the present invention. FIG. **20**B is a cross-sectional view of the plate piece taken along a line V-V shown in FIG. **20**A.

FIG. **21** is a cross sectional view of a duct in the image forming apparatus according to the second embodiment of the present invention.

DETAILED DESCRIPTION

Hereinafter, a configuration of a color printer **1** according to an embodiment of the present invention will be described with reference to the accompanying drawings. First, an overall configuration of the color printer **1** will be described, and second, specific components in the color printer **1** will be described in detail.

In the following description, directions concerning the color printer **1** will be referred to in accordance with orientation indicated by arrows in each drawing. Therefore, for example, a viewer's left-hand side appearing in FIG. **1** is referred to as a front side of the color printer **1**, and a right-hand side in FIG. **1** opposite from the front side is referred to as a rear side. A side which corresponds to the viewer's nearer side is referred to as a right-hand side for a user, and an opposite side from the right, which corresponds to the viewer's farther side is referred to as a left-hand side for the user. An up-down direction in FIG. **1** corresponds to a vertical direction of the color printer **1**. Further, the right-to-left or left-to-right direction of the color printer **1** may be referred to as a widthwise direction, and the front-to-rear or rear-to-front direction may be referred to as a direction of depth. The widthwise direction and the direction of depth are orthogonal to each other. Furthermore, directions of the drawings in FIGS. **2**-**21** are similarly based on the orientation of the color printer **1** as defined above and correspond to those with respect to the color printer **1** shown in FIG. **1** even when the drawings are viewed from different angles.

Overall Configuration of the Color Printer

The color printer **1** includes a feeder unit **20**, an image forming unit **30**, and an ejection unit **90**, which are arranged inside a body **10**. The feeder unit **20** is configured to feed a sheet P in the body **10**, the image forming unit **30** is configured to form an image on the sheet P being fed, and the ejection unit **90** is configured to eject the sheet P with the image formed thereon outside. A configuration of the body **10** of the color printer **1** will be described later in detail.

The feeder unit **20** includes a feeder tray **21** to store the sheet P therein and a sheet conveyer **22** to convey the sheet P from the feeder tray **21** to the image forming unit **30**.

The image forming unit **30** includes an optical scanner **40**, a plurality of (e.g., four) processing units **50**, a drawer **60**, a transfer unit **70**, and a fixing unit **80**.

The optical scanner **40** is arranged on one side of the plurality of processing units **50** along a direction orthogonal to an axial direction and to an aligning direction of photosensitive drums **51**, which will be described later in detail. In other words, the optical scanner **40** is arranged in an upper position with respect to the plurality of processing units **50**, in the body **10**. The optical scanner **40** includes a laser-beam emitter (not shown), a plurality of polygon mirrors (unsigned), lenses (unsigned), and a plurality of reflection mirrors (unsigned). Laser beams emitted from the laser-beam emitter for a plurality of (e.g., four) colors are reflected on the polygon mirrors and the reflection mirrors and transmit through the lenses to be casted to scan on surfaces of photosensitive drums **51** in the processing units **50**.

The plurality of processing units **50** are aligned in line, along a direction of depth (i.e., a front-rear direction) of the color printer **1**, orthogonally to the axial direction of rotation axes of the photosensitive drums **51**. Each of the processing units **50** includes the photosensitive drum **51**, which is rotatable about a rotation axis thereof extending along the widthwise direction, a charger **52** to electrically charge the photosensitive drum **51**, and a developer cartridge **53**. Each developer cartridge **53** includes a developer roller **54** to supply a developer agent (e.g., toner) to the photosensitive drum **51** and a toner container **56** to store the toner therein. All the processing units **51** are configured similarly but different from one another in colors of the toner contained in the toner containers **56**.

Each of the chargers **52** includes a charging wire **52**A and a grid electrode **52**B. The grid electrode **52**B is arranged in a position between the charging wire **52**A and the photosensitive drum **51**.

The drawer **60** supports the plurality of processing units **50** and is movable along the front-rear direction with respect to a pair of side frames **12**, **13**, which form lateral walls of the body **10** of the color printer **1**. Each of the side frames **12**, **13** is provided with a rail RA, solely one of which on the left is shown in FIGS. **2** and **3**, so that the drawer **60** is guided by the rails RA to move frontward or rearward along the front-rear direction. As shown in FIG. **2**, the drawer **60** can be drawn out of the body **10** of the color printer **10** through an opening **10**A, which is exposed when a front cover **11** arranged on the front side of the body **10** is opened. Thus, the processing units **50** are exposed to the outside atmosphere.

Referring back to FIG. **1**, the transfer unit **70** is arranged in a position between the feeder unit **20** and the drawer **60**. The transfer unit **70** includes a driving roller **71**, a driven roller **72**, a conveyer belt **73**, and transfer rollers **74**.

The driving roller **71** and the driven roller **72** are arranged to extend axially in parallel with each other in spaced-apart positions from each other along the front-rear direction so that the conveyer belt **73** being an endless belt is strained to roll around the driving roller **71** and the driven roller **72**. The conveyer belt **73** is arranged to have an upper outer surface thereof to be in contact with the photosensitive drums **51**. A plurality of (e.g., four) transfer rollers **74** are arranged in positions opposite from the photosensitive drums **51** across the conveyer belt **73**, and the conveyer belt **73** is in contact with the transfer rollers **74** at an upper inner surface thereof. Transfer bias under constant current control is applied to the transfer rollers **74** to transfer an image from the photosensitive drums **51** to the sheet P.

The fixing unit **80** is arranged in a rear position with respect to the processing units **50** and includes a heat roller **81** and a pressure roller **82**. The pressure roller **82** is arranged in a position to face the heat roller **81** and is urged against the heat roller **81**.

In each of the processing units **50** in the image forming unit **30** configured as above, the charger **52** electrically charges a surface of the photosensitive drum **51** evenly, and the surface of the photosensitive drum **51** is exposed to the laser beam emitted selectively based on image data from the optical scanner **40** in order to form a lower-potential regions, i.e., an electrostatic latent image representing the image to be formed on the sheet P, thereon. Thereafter, the toner is supplied to the latent image on the photosensitive drum **51** from the devel-

oper cartridge **53** through the developer roller **54**. Thus, the latent image is developed to be a toner image and carried on the surface of the photosensitive drum **51**.

When the sheet P supplied from the feeder unit **20** is carried on the conveyer belt **73** to a position between the photosensitive drum **51** and the transfer roller **74**, the toner image formed on the surface of the photosensitive drum **51** is transferred onto the sheet P. Thus, four colored images are sequentially overlaid on the surface of the sheet P to form a colored image. The sheet P with the transferred toner images is carried to a nipped position between the heat roller **81** and the pressure roller **82** in the fixing unit **80** to have the toner images thermally fixed thereon.

The ejection unit **90** includes a plurality of conveyer rollers **91** to convey the sheet P. The sheet P with the fixed image is ejected out of the body **10** of the color printer **1** by the conveyer rollers **91**.

Configuration of the Body **10** of the Color Printer **1**

As shown in FIG. **3**, the body **10** of the color printer **1** includes the paired side frames **12**, **13**, a first connecting frame **100** to connect upper portions of the side frames **12**, **13**, a second connecting frame **200** to connect lower rear portions of the side frames **12**, **13**, and lower beams **14** to connect lower ends of the side frames **12**, **13**. The lower beams **14** are elongated metal bars extending along the widthwise direction. One of the lower beams **14** is arranged on the front side of the side frames **12**, **13**, and another one of the lower beams **14** is arranged on the rear side of the side frames **12**, **13**.

The side frames **12**, **13** are resin plates, each of which is formed to have an approximate shape of a rectangle, and are arranged on the left side and the right side in the color printer **1** to have a predetermined amount of clearance there-between to accommodate the processing units **50** therein. The processing units **50** disposed in the clearance are supported by the side frames **12**, **13** via the drawer **60**. In the following description, one of the side frames **12**, **13** arranged on the right-hand side may be referred to as a right-side frame **12**, and the other one of the side frames **12**, **13** arranged on the left-hand side may be referred to as a left-side frame **13**.

The right-side frame **12** supports right-side ends of the processing units **50** via the drawer **60**. As shown in FIG. **3**, the right-side frame **12** includes flat parts **121** having flat surfaces **121**A, which spread orthogonally to the widthwise direction, and enhancing ribs **122**, which protrude inward or outward from the flat parts **121** along the widthwise direction. The right-side frame **12** is enhanced by a first metal beam **510** and a second metal beam **520** (see FIG. **5**), which will be described later in detail.

The left-side frame **13** is arranged to face the right-side frame **12** across the processing units **50** and supports left-side ends of the processing units **50** via the drawer **60**. The left-side frame **13** includes the flat parts (unsigned) and enhancing ribs (unsigned), which are formed in shapes similar to the flat parts **121** and the enhancing ribs **122** in the right-side frame **12**. On an outer side of the left-side frame **13** along the widthwise direction, a driving mechanism (not shown), including a plurality of gears to drive the photosensitive drums **51**, is disposed. Thus, the driving mechanism disposed on the left-side frame **13** can enhance rigidity of the left-side frame **13**.

The first connecting frame **100** is a metal frame forming a shape of a sleeve, which is hollow and provides a space inside, and a cross-section of the first connecting frame **100** taken along a plane orthogonal to the widthwise direction is closed. Widthwise ends of the first connecting frame **100** are connected to the side frames **12**, **13**. The first connecting frame **100** is arranged in an upper position with respect to the processing units **50** and accommodates the optical scanner **40** in the hollow space.

With the sleeve-shaped first connecting frame **100** connected to the side frames **12**, **13** at the widthwise ends thereof, the first connecting frame **100** can enhance rigidity of the side frames **12**, **13**. In this regard, while the optical scanner **40** is accommodated in the first connecting frame **100**, the first connecting frame **100** may not only provide the improved rigidity to the color printer **1** but also protect the optical scanner **40** securely.

The first connecting frame **100** is formed to have a dimension in the front-rear direction being substantially equivalent to a dimension in the front-rear direction of the drawer **60** and is arranged to overlap the processing units **50** in a perspective view projected along the vertical direction. Thus, due to the first connecting frame **100** arranged over the processing units **50**, the rigidity of the side frames **12**, **13** may be enhanced effectively by the first connecting frame **100**.

Meanwhile, the first connecting frame **100** is arranged to locate a center C1 thereof along the front-rear direction in a frontward position deviated from a center C of the side frames **12**, **13** along the front-rear direction. In other words, the first connecting frame **100** is arranged in a frontward off-centered position closer to the front ends rather than the rear ends of the side frames **12**, **13**.

More specifically, as shown in FIGS. **3** and **4**, the first connecting frame **100** is fixed to upper edges of the side frames **12**, **13** by screws S4 at widthwise ends of a top wall **101** thereof, and to L-shaped metal pieces **300**, which are fixed to the side frames **12**, **13**, at widthwise ends of a lower wall **102** thereof. Each of the L-shaped metal pieces **300** is a sheet of metal including a main part **300**A elongated along the front-rear direction and an extended part **300**B extended downward from the main part **300**A toward a side where the photosensitive drums **51** are disposed. The main part **300**A is arranged to overlap the first connecting frame **100** in a perspective view projected along the widthwise direction. The extended part **300**B supports a positioning shaft **310** (see also FIG. **1**), which is engageable with a rear part of the drawer **60** to place the drawer **60** in a correct position in the body **10** of the color printer **1**. Each of the L-shaped metal pieces is fixed to an inner surface of the side frames **12**, **13** along the widthwise direction.

As shown in FIGS. **1** and **3**, the second connecting frame **200** is a metal frame formed in a shape of a sleeve, which is hollow and provides a space inside. A cross-section of the second connecting frame **200** is closed when taken along the plane orthogonal to the widthwise direction. The second connecting frame **200** is coupled to the side frames **12**, **13** at widthwise ends thereof. The second connecting frame **200** is arranged in a lower position with respect to the processing units **50**.

Thus, the first connecting frame **100** and the second connecting frame **200** are arranged to align along the vertical direction to place the processing units **50** interposed therebetween. Therefore, central areas of the side frames **12**, **13**, i.e., areas coincident with the processing units **50** along the direction of rotation axes, can be effectively enhanced.

According to the configuration described above, a central area C2 of the second connecting frame **200** along the front-rear direction is arranged in a rearward position deviated from the center C of the side frames **12**, **13** along the front-rear direction. In other words, the second connecting frame **200** is arranged in the rearward off-centered position closer to the rear ends rather than the front ends of the side frames **12**, **13**.

Therefore, with regard to the relative position among the second connecting frame **200**, the side frames **12**, **13**, and the first connecting frame **100**, the first connecting frame **100** is disposed in the frontward position closer to the front ends of the side frames **12**, **13** while the second connecting frame **200** is disposed in the rearward position closer to the rear ends of the side frames **12**, **13**. Thus, the first connecting frame **100** and the second connecting frame **200** are disposed in diagonal positions with respect to each other in the side frames **12**, **13**. Accordingly, the rigidity of the body **10** of the color printer **1** may be effectively improved.

According to the configuration described above, the second connecting frame **200** is formed to range from a position in proximity to the rear end of the first connecting frame **100** to a position in proximity to the rear ends of the side frames **12**, **13** along the front-rear direction. Further, the second connecting frame **200** is arranged to overlap the first connecting frame **100**, at least partly, in the perspective view projected along the vertical direction.

Therefore, an entire range of the side frames **12**, **13** along the front-rear direction is enhanced by the first and second connecting frames **100**, **200**, and the rigidity of the first and second connecting frames **100**, **200** may be effectively improved.

Meanwhile, inside the second connecting frame **200**, a power board **400** to supply power to electrically movable components, such as the processing units **50**, is disposed. On the power board **400**, a transformer **401** (see FIGS. **1** and **2**) being one of elements composing a power circuit, is mounted. While the power board **400** is accommodated in the metal-made second connecting frame **200**, noises generated in the power board **400** may be prevented from being radiated.

As shown in FIGS. **5** and **6**, the first metal beam **510**, made of metal, is formed in a shape of an elongated bar longitudinally arranged along the vertical direction. The first metal beam **510** may be made of, but not limited to, iron. The first metal beam **510** is arranged along a planar face of the right-side frame **12**, which includes the flat surfaces **121**A of the flat parts **121**, and fixed to the outer side of the right-side frame **12** along the widthwise direction. With the first metal beam **510**, the resin-made right-side frame **12** is enhanced at the side; therefore, for example, compared to a right-side frame configured with resin only, the right-side frame **12** with improved rigidity may be provided.

The first metal beam **510** is formed in a shape of a bar having shorter sides and longer sides in a lateral view along the widthwise direction. In this regard, the shorter sides align with the front-rear direction of the right-side frame **12**, and a dimension of the shorter sides is substantially smaller with respect to a dimension of the right-side frame **12** along the front-rear direction. In particular, the dimension of the shorter sides of the first metal beam **510** along the front-rear direction is approximately at most 1/47 of the dimension of the right-side frame **12** along the front-rear direction. With the substantially smaller dimension with respect to the dimension of the resin-made right-side frame **12** along the front-rear direction, a weight of the color printer **1** can be reduced to be less compared to, for example, the conventional printer with a side frame consisting of a larger metal plate with planar dimension. The dimension of the first metal beam **510**, at a largest part, along the front-rear direction may be between 1/10 and 1/100 with respect to the dimension of a largest part of the right-side frame **12** along the front-rear direction, and it may even be preferable to set the ratio within a range between 1/40 and 1/50.

The first metal beam **510** is arranged to vertically penetrate through a duct **600**, which is arranged on the right-side frame **12**. An upper end portion **510**A of the first metal beam **510** is fixed to an upper part of the right-side frame **12** and to the L-shaped metal piece **300** while a lower end portion **510**B of the first metal beam **510** is engaged with a lower part of the right-side frame **12**. The duct **600** provides an air channel for the air, which is introduced by a fan **601** and conveyed to the processing units **50**.

As shown in FIG. **7**, the first metal beam **510** is formed of an elongated thin metal bar bent along the longitudinal direction to form a cross-sectional shape of an L. The first metal beam **510** includes a first section **511**, which spreads orthogonally to the widthwise direction, and a second section **512**, which spreads from a front end of the first section **511** outward along the widthwise direction. The first section **511** is formed to have two openings **511**B, which align along the vertical direction, in an upper-end portion **511**A of the first section **511**. In an upper one of the openings **511**B, a screw S1 to fasten the first metal beam **510** to one of the L-shaped metal pieces **300** on the right is inserted.

More specifically, in the L-shaped metal piece **300**, a bulge **301** protruding outward along the widthwise direction is formed. As shown in FIGS. **5** and **7**, the bulge **301** is arranged to protrude outward along the widthwise direction with respect to the flat part **121** through an opening (unsigned) formed in the flat part **121** of the right-side frame **12**. While the upper-end portion **511**A of the first section **511** of the first metal beam **510** is placed over the bulge **301**, the screw S1 is inserted through the upper opening **511**B in the upper-end portion **511**A and screwed to the L-shaped metal piece **300**. Thereby, the first metal beam **510** is fixed to the L-shaped metal piece **300** at the upper-end portion **511**A of the first section **511**. In this regard, the right-side frame **12** is interposed between the L-shaped metal piece **300**, which is arranged on the inner side of the right-side frame **12**, and the first metal beam **510**, which is arranged on the outer side of the right-side frame **12**.

Meanwhile, in a lower one of the openings **511**B formed in the upper-end portion **511**A of the first section **511**, a boss **127** formed in the right-side frame **12** is inserted to place the first metal beam **510** in a correct position with respect to the right-side frame **12**. In other words, by inserting the boss **127** of the right-side frame **12** into the lower one of the openings **511**B in the upper-end portion **511**A, the upper-end portion **511**A of the first section **511** is placed in the correct position with respect to the right-side frame **12**.

The lower end portion **510**B of the first metal beam **510** is engaged with a first engageable part **123** formed in the right-side frame **12**. As shown in FIGS. **8**A and **8**B, the first engageable part **123** includes a first engageable block **123**A, a second engageable block **123**B, and paired connecting blocks **123**C. The first engageable block **123**A is arranged on a right-hand side, i.e., an outer side, of the second section **512** of the first metal beam **510** along the widthwise direction and is engageable with the edge of the second section **512**. The second engageable block **123**B is arranged to extend leftward, i.e., inward along the widthwise direction, from a center of the first engageable block **123** along the front-rear direction to be engageable with the first section **511** of the first metal beam **510**. The paired connecting blocks **123**C are arranged to extend leftward from front and rear ends of the first engageable block **123**A to be connected to the flat part **121** of the right-side frame **12**.

The lower end portion **510**B of the first metal beam **510** is placed in a position between the first and second engageable blocks **123**A, **123**B, and the flat part **121** along the widthwise direction. Thus, the lower end portion **510**B of the first metal beam **510** is restricted from moving in the widthwise direc-

tion. In this regard, the lower end portion **510**B of the first metal beam **510** is arranged to protrude downward from the first engageable part **123**.

Therefore, while a thermal expansion rate of the resin-made right-side frame **12** is generally greater than a thermal expansion rate of the metal-made first metal beam **510**, the lower end portion **510**B of the first metal beam **510** is prevented from being disengaged from the first engageable part **123**.

Meanwhile, the lower end portion **510**B of the first metal beam **510** is engaged with the first engageable part **123**, in a lower area with respect to the lower end portion **510**B of the first metal beam **510**, and a clearance to absorb the difference in the thermal expansion rates is reserved. Thereby, even when the right-side frame **12** is thermally contracted, the lower end portion **510**B is prevented from being in conflict with by another part of the body **10** or other components in the color printer **1**.

As shown in FIGS. **5** and **6**, the second metal beam **520** is in a structure similar to the first metal beam **510**. Therefore, the second metal beam **520** includes a first section **521** and a second section **522**, which are similar to the first section **511** and the second section **512** of the first metal beam **510**. The second metal beam **520** is arranged on an inner side with respect to the first metal beam **510** along the widthwise direction. The second metal beam **520** is fixed to the right-side frame **12** and arranged to extend longitudinally along the front-rear direction, orthogonally to the first metal beam **510**. More specifically, the second metal beam **520** and the first metal beam **510** are arranged to overlap each other at longitudinal center portions thereof, when viewed laterally along the widthwise direction, to intersect crosswise with each other. With the intersecting first and second metal beams **510**, **520**, the rigidity of the right-side frame **12** can be improved even more.

The second metal beam **520** is arranged in an orientation to have the first section **521** to extend orthogonally to the widthwise direction, more specifically, along the flat surfaces **121**A of the flat surfaces **121**A of the flat parts **121** in the right-side frame **12**, in an orientation, in which an edge of the second section **522** faces inward (leftward) along the widthwise direction. In other words, the edge of the second section **512** of the first metal beam **510** and the edge of the second section **522** of the second metal beam **520** face opposite directions from each other along the widthwise direction. Therefore, flat surfaces of the first section **511** in the first metal beam **510** and the first section **521** in the second metal beam **520** are placed in close contact with each other. Accordingly, the second beam **520** can be firmly held in the position between the first metal beam **510** and the right-side frame **12** while the second metal beam **520** is restricted from being distorted.

The second metal beam **520** is fixed to the right-side frame **12** at a front-end tab **520**A while a rear end **520**B of the second metal beam **520** is engaged with a second engageable part **124** formed in the right-side frame **12**. As shown in FIGS. **9**A and **9**B, the second engageable part **124** includes a first restrictive block **124**A, a second restrictive block **124**B, and a third restrictive block **124**C. The first restrictive block **124**A is arranged on a right-hand side, i.e., the outer side, of the second metal beam **520** along the widthwise direction. The second restrictive block **124**B is arranged in an upper position with respect to the second metal beam **520**. The third restrictive block **124**C is arranged on a left-hand side, i.e., an inner side, of the second metal beam **520**.

The third restrictive block **124**C is formed to have a right-side end thereof to fit with the shape of the second metal beam **520**. Therefore, the second metal beam **520** is restricted by the first restrictive block **124**A and the third restrictive block **124**C from being moved in the widthwise direction while the second section **522** of the second metal beam **520** is restricted from being moved vertically by the second restrictive block **124**B and the third restrictive block **124**.

While the rear end **520**B of the second metal beam **520** is engaged with the second engageable part **124**, in a rearward area with respect to the rear end **520**B of the second metal beam **520**, a clearance to absorb the difference in the thermal expansion rates is reserved. Thereby, even when the right-side frame **12** is thermally contracted, the rear end **520**B is prevented from being in conflict with another part of the body **10** or other components in the color printer **1**.

The arrangement of the first metal beam **510** and the second metal beam **520** will be described in detail hereinbelow.

As shown in FIG. **10**, the first metal beam **510** overlaps at least one of the processing units **50** at a longitudinal central part **510**C in a perspective view laterally projected along the widthwise direction. In this regard, the upper end portion **510**A and the lower end portion **510**B of the first metal beam **510** are located in vertically outer side areas with respect to the processing units **50**. Therefore, a force applied from the processing units **50** to the right-side frame **12**, in particular, a force applied to a part of the right-side frame **12** which supports the drawer **60**, can be borne by the first metal beam **510** rigidly.

The upper end portion **510**A of the first metal beam **510** is arranged to overlap the first connecting frame **100** in the perspective view projected laterally along the widthwise direction. In this arrangement, deformation of the first metal beam **510** in the widthwise direction can be restricted by the first connecting frame **100**, and the rigidity of the right-side frame **12** may be enhanced even more.

In other words, the upper end portion **510**A of the first metal beam **510** is fixed to a more rigid part of the right-side frame **12**, i.e., a connected area where the right-side frame **12** is connected with the first connecting frame **100**, than other less rigid parts. Therefore, while the second metal beam **520** is supported by the first metal beam **510**, which is fixed to the more rigid part and is more difficult to deform, the second metal beam **520** can be restricted from being deformed more effectively. Accordingly, the rigidity of the right-side frame **12** may be enhanced even more.

Further, the second metal beam **520** is arranged to overlap the drawer **60** in the perspective view projected laterally along the widthwise direction. In this regard, while the drawer **60** should be movably supported by the side frames **12**, **13** to move with respect to the body **10** of the color printer **1**, the movable area for the drawer **60**, needs to be from the first and second connecting frames **100**, **200**. Meanwhile, with the second metal beam **520** arranged to overlap the drawer **60** in the perspective view projected laterally along the widthwise direction, the part of the right-side frame **12** corresponding to the movable area for the drawer **60** can be enhanced by the second metal beam **520**.

While the second metal beam **520** is made of iron and formed to have a thickness of, for example, 1.6 mm, the first metal beam **510** is formed to be more rigid than the second beam **520**. The rigidity of the first metal beam **510** may be enhanced to be higher than the rigidity of the second metal beam **520** by, for example, being formed to be thicker than the second metal beam **520** or by being formed in a more rigid material than iron such as stainless steel. In this regard, the rigidity of the metal beams should mean difficulty in deformation. For example, the rigidity of the first and second metal beams **510**, **520** may be determined by bendable amounts of the first metal beam **510** and the second metal beam **520** when

a same intensity of load is equally applied to the first and second metal beams **510**, **520**.

When, for example, the color printer **1** falls down from a higher place and is subject to a certain amount of load, the drawer **60** may be urged against the right-side frame **12**, and the right-side frame **12** may tend to deform at an area in the vicinity of the second metal beam **520**. However, with the rigidity difference between the first metal beam **510** and the second metal beam **520**, the deformation around the second metal beam **520** may be restricted by the first metal beam **510**, of which rigidity is higher than the rigidity of the second metal beam **520**.

As mentioned above, the first metal beam **510** with the higher rigidity is arranged on the side opposite from the plurality of processing units **50** across the second metal beam **520** to contact the second metal beam **520**. Therefore, when, for example, the color printer **1** falls down from a higher place and is subject to a certain amount of load, the load may be transmitted through the second metal beam **520**, which extends along the aligning direction of the plurality of processing units **50**, to the first metal beam **510**, of which rigidity is higher than the second metal beam **520**. Therefore, the load may be effectively absorbed in the first and second metal beams **510**, **520** so that deformation of the right-side frame may be effectively prevented.

As shown in FIG. **11**, while the right-side frame **12** is enhanced by the first and second metal beams **510**, **520**, resilient forces from a plurality of spring electrodes **710**, which supply power to the processing units **50**, and a plurality of spring electrodes **730**, which supply power to the transfer unit **70**, are applied to the right-side frame **12** enhanced by the first and second metal beams **510**, **520**. More specifically, on the outer side of the right-side frame **12** along the widthwise direction, a substrate **720** is arranged. The substrate **720** converts the electricity supplied from the power board **400** (see FIG. **1**) into suitable electricity and distributes the converted electricity to the processing units **50** and the transfer unit **70** via the spring electrodes **710**, **730**. With the substrate **720** arranged on the outer side of the right-side frame **12** along the widthwise direction, it is noted that the drawer **60** is prevented from being interfered with by the substrate **720** when the drawer **60** is moved into or out of the body **10** of the color printer **1**.

The right-side frame **12** includes a plurality of substrate supports **125**, **126** to support the substrate **720** on the outer side thereof, i.e., on the opposite side from the processing units **50**, along the widthwise direction (see also FIG. **5**). Each of the substrate supports **125** has a claw (unsigned), which is deformable along the direction orthogonal to the widthwise direction. The substrate supports **125** support the substrate **720** by placing the claws engaged with openings **721** and cutouts **722** formed in the substrate **720**. In upper positions in the substrate **720**, through holes **723** are formed, and screws penetrating through the through holes **723** are fastened to the substrate supports **126**. Thus, the substrate supports **126** support the substrate **720** by the fastening.

As illustrated in FIG. **12**, the spring electrodes **710** are arranged in upper positions with respect to the spring electrodes **730**. Each of the spring electrodes **710** includes a compressed coiled spring and is supported by the right-side frame **12** in a compressed condition to be resiliently urged against one of electrodes **50**A of the processing units **50**. The spring electrodes **710** may be, but not limited to, directly in contact with the electrodes **50**A of the processing units **50**. For example, the spring electrodes **710** may be in indirectly contact with the electrodes of the processing units **50** via intermediate conductors arranged on the drawer.

The spring electrodes **730** are arranged in lower positions with respect to the spring electrodes **710**. Each of the spring electrodes **730** includes a first spring electrode **731**, a second spring electrode **732**, and an intermediate conductor **733**. The first spring electrode **731** is connected with an electrode **70**A of the transfer unit **70**, and the second spring electrode **732** is connected with the substrate **720**. The intermediate conductor **733** connects the first spring electrode **731** and the second spring electrode **732** with each other.

The first spring electrode **731** is a compressed coiled spring electrode and is supported by the right-side frame **12** in a compressed condition to be resiliently urged against one of the electrodes **70**A of the transfer unit **70**. More specifically, while the right-side frame **12** includes a main frame **810** and a subsidiary frame **820**, which is fixed to an outer side of the main frame **810** (see also FIG. **6**), the first spring electrode **731** is arranged in between the transfer unit **70** and the subsidiary frame **820**.

The intermediate conductor **733** is arranged to penetrate through the subsidiary frame **820** along the widthwise direction.

The second spring electrode **732** is a compressed coiled spring electrode and is supported by the subsidiary frame **820** in a compressed condition in between the intermediate conductor **733** and the substrate **720**.

With the spring electrodes **710**, **730** with resiliency, the spring electrodes **710**, **730** can be connected to the processing units **50**, the transfer unit **70** and to the substrate **720** steadily. Further, the processing units **50** can be restricted from being moved in the widthwise direction with respect to the right-side frame **12**. While the resilient force from the spring electrodes **710**, **730** is applied to the right-side frame **12**, with the first and second metal beams **510**, **520** enhancing the right-side frame **12**, the rigidity of the right-side frame **12** can be enhanced, and deformation of the right-side frame **12** can be restricted.

In the right-side frame **12**, a plurality of holes **12**A, in which the spring electrodes **710**, **730** are inserted to be supported, are formed along a direction of thickness (i.e., the widthwise direction). While the holes **12**A may decrease intensity of the right-side frame **12**, with the first and second metal beams **510**, **520** enhancing the right-side frame **12**, the rigidity of the right-side frame **12** can be maintained or enhanced, and deformation of the right-side frame **12** can be restricted.

The spring electrodes **710** include, as shown in FIG. **5**, four (4) electrodes **710**A for wires, four (4) electrodes **710**B for developers, four (4) electrodes **710**C for grids, and two (2) electrodes **710**D for drums. The electrodes **710**A for wires are electrodes to supply electricity to the charging wires **52**A. Each of the charging wires **52**A is provided with one of the electrodes **710**A, and the electrodes **710**A as well as the charging wires **52**A are arranged at equal intervals from one another to align along the front-rear direction.

The electrodes **710**B for developers are electrodes to supply electricity, more specifically, developer bias, to the developer cartridges **53**. Each of the developer cartridges **53** is provided with one of the electrodes **710**B, and the electrodes **710**B as well as the developer cartridges **53** are arranged at equal intervals from one another to align along the front-rear direction. More specifically, each of the electrodes **710**B supplies electricity to the developer roller **54** and the supplier roller **55** in one of the developer cartridges **53**. The electrodes **710**C for grids are electrodes to supply electricity to the grid electrodes **52**B. Each of the grid electrodes **52**B is provided with one of the electrodes **710**C, and the electrodes **710**C as well as the grid electrodes **52**B are arranged at equal intervals

from one another to align along the front-rear direction. The electrodes **710**D for drums are electrodes to supply electricity to the photosensitive drums **51** and are arranged in lower positions with respect to the electrodes **710**C for grids.

The spring electrodes **730** supply electricity, more specifically, transfer bias, to the transfer rollers **74**. Each of the transfer rollers **74** is provided with one of the spring electrodes **730**, and the spring electrodes **730** as well as the transfer rollers **74** are arranged at equal intervals from one another to align along the front-rear direction. The first metal beam **510** is arranged in a position between two electrodes in midst positions along the front-rear direction among the four electrodes (e.g., the electrodes **710**A for wires), which share the electricity from the same source.

As shown in FIGS. **13** and **14**, on the inner side of the right-side frame **12**, arranged are a plurality of support projections **121**B, first projections **121**C, second projections **121**D, and third projections **121**E. The plurality of support projections **121**B are formed to protrude from the inner surface of the flat parts **121** inwardly to support the spring electrodes **710**. The first projections **121**C, the second projections **121**D, and the third projections **121**E are arranged to contact the drawer **60** when the drawer **60** is moved toward the right-side frame **12**. In other words, when the drawer **60** is moved toward the right-side frame **12**, portions in the right-side frame **12** that should first come into contact with the drawer **60** are the first, second, and third projections **121**C-**121**E, whereas the remainder of the right-side frame **12** should contact the drawer **60** either at the same time as the first, second, and third projections **121**C-**121**E or later.

The first projections **121**C, the second projections **121**D, and the third projections **121**E are arranged in positions on the outer side with respect to the plurality of support projections **121**B along the widthwise direction and in positions to overlap the drawer **60** when viewed along the widthwise direction. More specifically, the first, second, and third projections **121**C-**121**E are arranged outside a surrounded area AR, which is indicated by a broken line in FIG. **13**. The surrounded area AR is an area enclosed by lines connecting outer peripheries of the support projections **121**B. More specifically, the surrounded area AR is an area enclosed by straight lines contacting the outer peripheries of the support protrusions **121**B and lines drawn along the outer peripheries of the support protrusions **121**B.

The first projections **121**C include two (2) first projections **121**C, which are arranged to align vertically in lower-frontward positions with respect to the surrounded area AR apart from the surrounded area AR. In other words, the first projections **121**C are in frontward positions with respect to the plurality of support projections **121**B along the front-rear direction, more specifically, in positions closer to the front end of the right-side frame **12** than the plurality of support projections **121**B. Therefore, when, for example, the color printer **1** falls from a higher place, the drawer **60** may be moved toward the right-side frame **12** and contact the first projections **121**C. In this regard, impact from the drawer **60** transmitted to the right-side frame **12** is received at a front end portion of the right-side frame **12**, which is a part rather difficult to be deformed within the right-side frame **12**. Therefore, compared to a configuration, in which the impact from the drawer when the color printer falls is received at a central part of the right-side frame, an amount of deformation of the resin-made right-side frame **12** may be restrained to be smaller.

Further, the first projections **121**C on the positions described above are arranged to contact the front end portion of the drawer **60** when the drawer **60** moves along the widthwise direction. Therefore, for example, compared to a configuration, in which the first projections are arranged to contact a central portion of the drawer rather than the front end portion, a deformation amount of the right-side frame **12** may be restrained to be even smaller.

The second projections **121**D include two (2) second projections **121**D arranged in lower positions with respect to a rear part of the surrounded area AR apart from the surrounded area AR. One of the second projections **121**D is in an upper-frontward position with respect to the other. In these positions, the second projections **121**D are arranged to contact a rear end portion of the drawer **60** when the drawer **60** moves along the widthwise direction. Thus, the first projections **121**C and the second projections **121**D are in positions to contact the end portions of the drawer **60** along the front-rear direction respectively. Therefore, the load from the drawer **60**, transmitted from the front and rear end portions of the drawer **60**, can be distributed in the right-side frame **12** through the first and second projections **121**C, **121**D. Accordingly, the deformation amount of the right-side frame **12** may be restrained to be even smaller.

The third projections **121**E include three (3) third projections **121**E, which are arranged to align vertically in upper apart positions with respect to the surrounded area AR to be in contact with an upper end portion of the drawer **60** when the drawer **60** moves along the widthwise direction. Thus, the load from the drawer **60** can be distributed in the first-third projections **121**C-**121**E so that the deformation amount of the right-side frame **12** may be restrained to be even smaller.

In this regard, each of the third projections **121**E is formed in a shape of a rib elongated along the front-rear direction. Therefore, the load from the drawer **60** can be distributed in the elongated area containing the third projections **121**E so that the deformation of the right-side frame **12** may be restrained even more effectively. A length of each third projection **121**E may be, for example, 254.2 mm.

As shown in FIGS. **15**A and **15**B, widthwise ends of the first-third projections **121**C-**121**E on the inner side align with widthwise ends of the support projections **121**B on the inner side (the third projections **121**E are not shown in FIGS. **15**A-**15**B). In other words, a first amount L1 of clearance between the first-third projections **121**C-**121**E and the drawer **60** is equal to a second amount L2 of clearance between the support projections **121**B and the drawer **60**. The first amount L1 and the second amount L2 may be, for example, 1.3 mm.

Thereby, the impact from the drawer **60** falling down may be dispersed to the first-third projections **121**C-**121**E and the support projections **121**B. Accordingly, deformation of the right-side frame **12** may be moderated or prevented. In particular, while the drawer **60** is in the elongated form to be longer in the front-rear direction than in the vertical direction, the drawer **60** may contact the projections arranged on the side closer to the edge of the right-side frame **12**, such as the first projections **121**C, than the support projections **121**B more easily. Therefore, the impact from the drawer **60** may not fall only on the support projections **121**B but may be distributed, and reaction force may be prevented from concentrating on the central part of the right-side frame **12** so that an amount of distortion may be reduced.

It is to be noted that the first amount L1 of clearance between the first-third projections **121**C-**121**E and the drawer **60** may not necessarily be equal to the second amount L2 of clearance between the support projections **121**B and the drawer **60** but may be smaller. Even in this configuration, the first-third projections **121**C-**121**E should contact the drawer **60** earlier than the support projections **121**B, and the impact from the drawer **60** may be transmitted to the edge portions of

the right-side frame **12**, which are more difficult to deform than the central portion. Therefore, the amount of distortion in the right-side frame **12** may be reduced. The first amount L1 of the clearance between the first-third projections **121**C-**121**E and the drawer **60** along the widthwise direction may be, for example, 1.3 mm.

According to the embodiment described above, further to the effectiveness having been mentioned above, while the first and second metal beams **510**, **520** have the first section **511** and the first section **521**, which overlap each other along the widthwise direction, the first and second metal beams **510**, **520** are stably attached to the right-side frame **12** via the first section **511** and the first section **521**. Further, with the first sections **511**, **521** of the first and second metal beams **510**, **520**, the rigidity of the metal beams **510**, **520** can be increased.

Although an example of carrying out the invention has been described, those skilled in the art will appreciate that there are numerous variations and permutations of the color printer that fall within the spirit and scope of the invention as set forth in the appended claims. It is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or act described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

Different embodiments of the present invention will be described below. In the different embodiments, items or structures which are the same as or similar to items or structures described in the previous embodiment will be referred to by the same reference signs, and description of those will be omitted.

In a second embodiment, a form of the first metal beam **510** may not necessarily be limited to the bent-formed bar but may be, for example, in a shape of a cylindrical round rod, such as a first beam **530** shown in FIGS. **16** and **17**. With the cylindrical first beam **530**, which is in a compact form, rigidity of the first beam **530** may be maintained or improved.

More specifically, according to the second embodiment, the first beam **530** is a metal-made round rod with longitudinal (upper and lower) ends thereof being partly cutoff so that each longitudinal end portion of the first beam **530** is formed to have a first planar surface **531** along the longitudinal direction. The first beam **530** is engaged with the first engageable part **123**, which is as described in the previous embodiment, at the lower end thereof. Meanwhile, the upper end of the metal beam **530** is retained in a clearance between a metal-made resilient plate member **540** and the right-side frame **12**.

A diameter of the first beam **530** may be, for example, 5 mm. Meanwhile, a dimension of a thickest part of the first beam **530** at the longitudinal ends, in which the first planar surfaces **531** are formed, i.e., a dimension along a direction orthogonal to the first planar surface **531**, may be 3.8 mm.

The plate member **540** is formed to have a first section **541**, a second section **542**, and a third section **543**. The first section **541** spreads orthogonally to the widthwise direction, and while the third section **543** extends from a lower end of the first section **541** outwardly along the widthwise direction, the second section **542** extends from a widthwise outer end of the second section **543**. As shown in FIGS. **18** and **20**A-**20**B, the plate member **540** is fixed to the right-side frame **12** at the first section **541** while the second section **542** floats to form a free end.

In this regard, the second section **542** being the free end urges the upper end of the first beam **530** toward the right-side frame **12**. More specifically, the second section **542** urges the upper end of the first beam **530** toward support ribs **121**F, which will be described later in detail, of the right-side frame **12**. Thus, the upper end of the first beam **530** is held in the clearance between the second section **542** and the right-side frame **12**. Accordingly, the upper end of the first beam **530** is resiliently supported by the plate member **540** so that, when the load from the drawer **60** is applied to the right-side frame **12**, damage at a part, wherein the upper end of the first beam **530** is attached to the right-side frame **12**, can be restrained by resilient deformation of the plate member **540**.

As shown in FIG. **20**B, further, a side of the second section **542** facing the first beam **530** forms a second planar surface **542**A, which is arranged to be in surface contact with the first planar surface **531**. Thus, while the second section **542** of the plate member **540** and the upper end of the first beam **530** contact each other at the first and second planar surfaces **531**, **542**A, the upper end of the first beam **530** may be stably supported by the second section **542** of the plate member **540**.

Further, in the first planar surface **531** of the first beam **530**, a through-hole **532** which penetrates the first planar surface **532** toward the right-side frame **12**, is formed. In the through-hole **532**, a projection **121**G, which projects from the surface of the flat part **121** in the right-side frame **12** toward the first beam **530**, is inserted. Thereby, the first beam **530** is restricted from moving vertically with respect to the right-side frame **12**.

Moreover, the plate member **540** is formed to have an engagement section **541**A in an upper end portion of the first section **541**. The engagement section **541**A is inserted in an engagement hole **121**H, which is formed in one of the flat parts **121** in the right-side frame **12**, so that the engagement section **541**A is engaged with the engagement hole **121**H along the direction of shorter sides of the plate member **540**.

As shown in FIGS. **17**, **19**A, and **19**B, in upper positions in the right-side frame **12** in a central area along the front-rear direction, a plurality of support ribs **121**F to contact an upper part (e.g., at approximately ⅓ of the length from the upper end) of the first beam **530** are formed. The support ribs **121**F are formed to protrude from the flat part **121** of the right-side frame **12** toward the first beam **530** and are arranged to align along the longitudinal direction of the first beam **530**.

With the plurality of support ribs **121**F, when the load from the drawer **60** is applied to the right-side frame **12**, the right-side frame **12** and the first beam **530** contact each other at the plurality of points; therefore, the load may be dispersed in the first beam **530** and restrained from concentrating on a single or smaller area in the first beam **530**.

Further, as shown in FIG. **19**B, one of the support ribs **12**F is arranged to partly overlap upper two (2) of three (3) third projections **121**E along the widthwise direction across the flat part **121**. Therefore, the load transmitted to the upper two of the third projections **121**E can be accepted by the metal-made first beam **530** through the support rib **121**F.

As shown in FIGS. **16** and **17**, the duct **600** includes a first duct part **610**, a second duct part **620**, and a shield member **630**. The first duct part **610** is formed integrally with the right-side frame **12** and is formed to have a cross-sectional shape of a sideward-turned U being open outwardly along the widthwise direction. The second duct part **620** is arranged to cover the opening of the sideward-turned U of the first duct part **610**. The shield member **630** is arranged inside the duct **600**. Each of the first duct part **610** and the second duct part **620** has a portion elongated along the front-rear direction and a portion elongated long the vertical direction and, therefore, has an approximate shape of an L when viewed along the widthwise direction.

The first duct part **610** includes a bottom part **611** in a position corresponding to a bottom of the sideward-turned U-shape, i.e., along the vertical direction, and a pair of side

parts **612** spreading from an upper end and a lower end of the bottom part **611** outwardly along the widthwise direction. As shown in FIG. **21**, in positions in the bottom part **611** of the first duct part **610** corresponding the processing units **50** along the widthwise direction, a first outlet **641**, a second outlet **642**, a third outlet **643**, and a fourth outlet **644**, through which the air to be blown toward the chargers **52** in the processing units **50** is discharged, are formed to align along the front-rear direction.

As shown in FIGS. **17** and **21**, each of the paired side parts **612** is formed to have a groove **612**A, through which the first beam **530** is arranged penetrate the first duct part **610**. A dimension of the groove **612**A along the front-rear direction is substantially equal to a diameter of the first beam **530**, and a depth of the groove **612**A, i.e., a dimension of the groove **612**A along the widthwise direction, is greater than the diameter of the first beam **530**. Further, a bottom of the groove **612**A, i.e., a closed end along the widthwise direction of the groove **612**A, does not reach the bottom part **611** of the first duct part **610** but is at a position outwardly apart from the bottom part **611** along the widthwise direction.

The shield member **630** is a resin piece, and a part of which is arranged in a position to block a part of an air path in the duct **600**. Therefore, a cross-section of the air path in the duct is smaller at the part where the shield member **630** is arranged than the other part where the shield member **630** is not arranged. More specifically, the shield member **630** is arranged in a position between the second outlet **642** and the third outlet **643** along the front-rear direction. The shield member **630** includes a pair of covering walls **631** and an upstream-side angled wall **632** and a downstream-side angled wall **633**, which are formed integrally.

The covering walls **631** are walls to cover the first beam **530** from the air path and arranged to contact inner surfaces of the side parts **612**. Each covering wall **631** is formed to have a U-shaped groove **631**A at a position corresponding to the groove **612**A in the side part **612**.

The upstream-side angled wall **632** is arranged in a position between the paired covering walls **631** to incline with respect to a blowing direction, which is indicated by an arrow in FIG. **21**. More specifically, the upstream-side angled wall **632** is formed to incline to be separated farther away from the bottom part **611** as the upstream-side angled wall **632** spreads toward the downstream of the blowing direction. Therefore, sudden reduction of the cross-section of the air path at the area in the vicinity of the shield member **630** may be prevented, and a smooth flow of the air in the duct **600** may be maintained.

The downstream-side angled wall **633** is arranged in a position between the paired covering walls **631** on a downstream side of the upstream-side angled wall **632** with respect to the blowing direction and inclines with respect to the blowing direction. More specifically, the downstream-side angled wall **633** is formed to incline to approach closer to the bottom part **611** as the downstream-side angled wall **633** spreads toward the downstream of the blowing direction. Therefore, sudden increase of the cross-section of the air path at the area in the vicinity of the shield member **630** may be prevented, and a smooth flow of the air in the duct **600** may be maintained.

The upstream-side angled wall **632** and the downstream-side angled wall **633** are arranged to be spaced apart from the second duct part **620** (see FIG. **17**) and from the bottom part **611**. With this arrangement, the air is allowed to flow by both sides of the upstream-side angled wall **632** and the downstream-side angled wall **633**, i.e., a right-hand side and a left-hand side along the widthwise direction.

The first beam **530** is arranged to penetrate the shield member **630** at a position between the upstream-side angled wall **632** and the downstream-side angled wall **633** to be shielded. Thereby, the air current may be restrained from being disturbed by the first beam **530** but may be allowed to flow smoothly in the duct **600**.

Further, while the first beam **530** is formed in the compact shape of the round rod, the first beam **530** may be easily accommodated in the position between the upstream-side angled wall **632** and the downstream-side angled wall **633**, and disturbance of the air current by the first beam **530** may be restrained.

In the embodiments described above, the first metal beam **510** and the first beam **530** are arranged along a direction orthogonal to the aligning direction of the plurality of processing units **50**; however, the first metal beam and the first beam may be arranged along a direction, which is not necessarily orthogonal to the aligning direction, as long as the beam should intersect with the aligning direction.

For another example, the processing units **50** in the image forming unit **30** may be replaced with drum cartridges, in each of which a developer cartridge containing a developer roller is removably installed and is equipped with a photosensitive drum.

For another example, the metal-made plate member **540** providing resiliency may be replaced with a resin-made resilient member or a metal-made or resin-made rod member.

For another example, the spring electrodes **710**, **730** may not necessarily include the compressed coiled springs but may include, for example, blade springs or torsion springs.

For another example, the embodiment described above may not necessarily be applied to a color printer but may be employed in, for example, a monochrome printer, a copier, or a multifunction peripheral device.

What is claimed is:

1. An image forming apparatus, comprising:

a plurality of image forming units, each of which comprises a photosensitive drum configured to be rotatable about a rotation axis, the plurality of image forming units being arranged to align along an aligning direction orthogonal to a direction of rotation axes of the photosensitive drums;

a first frame made of resin and arranged on one side of the plurality of image forming units along the direction of rotation axes, the first frame being configured to support the plurality of image forming units;

a first beam made of metal and formed in an elongated shape longitudinally along a direction to intersect with the aligning direction of the plurality of image forming units, the first beam being arranged along a planar face of the first frame and fixed to the planar face of the first frame; and

a second beam formed in an elongated shape extending along the aligning direction, the second beam being arranged along the planar face of the first frame to intersect with the first beam and fixed to the planar face of the first frame,

wherein rigidity of the first beam is higher than rigidity of the second beam.

2. The image forming apparatus according to claim **1**,

wherein the first beam and the second beam are arranged on an outer side of the first frame; and

wherein the first beam is arranged on a side opposite from the plurality of image forming units across the second beam to contact the second beam.

3. The image forming apparatus according to claim **1**,

wherein the first beam is formed in a shape of a round rod.

4. The image forming apparatus according to claim 1, wherein the first frame comprises a plurality of ribs, the plurality of ribs being arranged to contact the first beam and to align along a longitudinal direction of the first beam.

5. The image forming apparatus according to claim 1, further comprising:

a resilient member fixed to the first frame at one part, another part of the resilient member forming a free end;

wherein the first beam is supported at one end thereof in a position between the another part of the resilient member and the first frame.

6. The image forming apparatus according to claim 5, wherein the one end of the first beam is formed to have a first planar surface along a longitudinal direction of the first beam; and

wherein the another part of the resilient member is formed to have a second planar surface, the second planar surface being arranged to be in surface contact with the first planar surface.

7. The image forming apparatus according to claim 1, wherein the first beam is arranged to overlap the plurality of image forming unit at a longitudinal central part thereof, when projected along the direction of rotation axes, and longitudinal ends of the first beam are arranged on outer sides of the plurality of image forming units.

8. The image forming apparatus according to claim 1, wherein the second beam is formed of a metal bar having a first section, which spreads orthogonally to the direction of rotation axes, and a second section, which spreads from the first section along the direction of rotation axes.

9. The image forming apparatus according to claim 1, further comprising:

a second frame arranged to face the first frame across the plurality of image forming units; and

a connecting frame configured to be connected to the first frame and the second frame,

wherein one of longitudinal ends of the first beam is arranged to overlap the connecting frame when projected along the direction of rotation axes.

10. The image forming apparatus according to claim 1, wherein the first frame comprises a plurality of substrate supports, which are configured to support a substrate, the substrate being configured to supply electricity to the plurality of image forming units via spring electrodes, and

wherein the spring electrodes are arranged in positions between the substrate and the plurality of image forming units in a compressed condition.

11. The image forming apparatus according to claim 10, wherein the plurality of substrate supports are arranged on an opposite side from the plurality of image forming units across the first frame; and

wherein the first frame comprises through-holes, in which the spring electrodes are arranged to penetrate therethrough.

12. The image forming apparatus according to claim 1, wherein the first beam is arranged longitudinally along a direction orthogonally to the aligning direction of the plurality of image forming units.

13. The image forming apparatus according to claim 1, further comprising:

a drawer configured to support the plurality of image forming units, the drawer being supported by the first frame movably to move along the aligning direction,

wherein the second beam is arranged to overlap the drawer when projected along the direction of rotation axes.

* * * * *